U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

AMR Plenary

VTO Lightning Round

“*Pass-the-Mic*”

Panels

Panel 1 – Partnerships, Engines and Fuels, and Materials

Christy Cooper, Director, U.S. DRIVE Partnership

Ken Howden, Director, 21st Century Truck Partnership

Gurpreet Singh, Program Manager, Advanced Combustion Engines and Fuel Technologies; Acting Program Manager, Materials Technology

Michael Weismiller, Technology Manager

Kevin Stork, Technology Manager

Sarah Kleinbaum, Technology Manager

Felix Wu, Technology Manager

Jerry Gibbs, Technology Manager

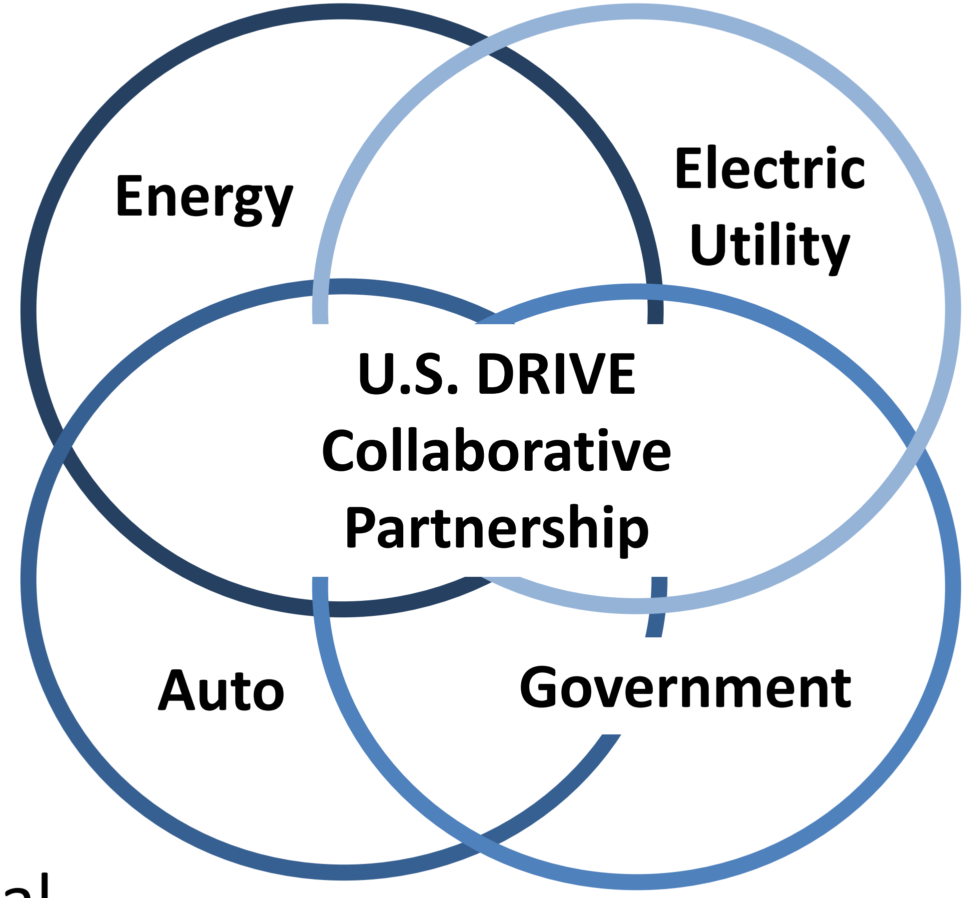
USDRIVE

DRIVING RESEARCH AND INNOVATION FOR
VEHICLE EFFICIENCY AND ENERGY SUSTAINABILITY

U.S. DRIVE is a voluntary government-industry partnership focused on advanced automotive and related energy infrastructure technology R&D

A framework for collaboration

- Executive Steering Group: ***Strategic engagement*** among senior leadership
- 13 technical teams: ***Frequent and regular technical interaction***



VALUE to DOE:

✓ Industry perspective ***supports alignment*** of research priorities, ***ensures relevance*** of publically-funded research, ***prevents duplication***

✓ Information-sharing and leveraging of technical expertise ***accelerates progress***

U.S. DRIVE in 2019…

PARTNERS:

- Auto: *FCA US, Ford, GM*
- Energy: *BP, Chevron, ExxonMobil, Phillips66, Shell*
- Utility: *DTE, EPRI, Southern California Edison*

NEW PARTNERS:
(first time since 2010!)

- American Electric Power
- Duke Energy

CORE PORTFOLIO:

- Batteries, electric drive, grid integration
- Advanced combustion engines and fuels
- Lightweight materials
- Integrated systems analysis
- Fuel cells, hydrogen

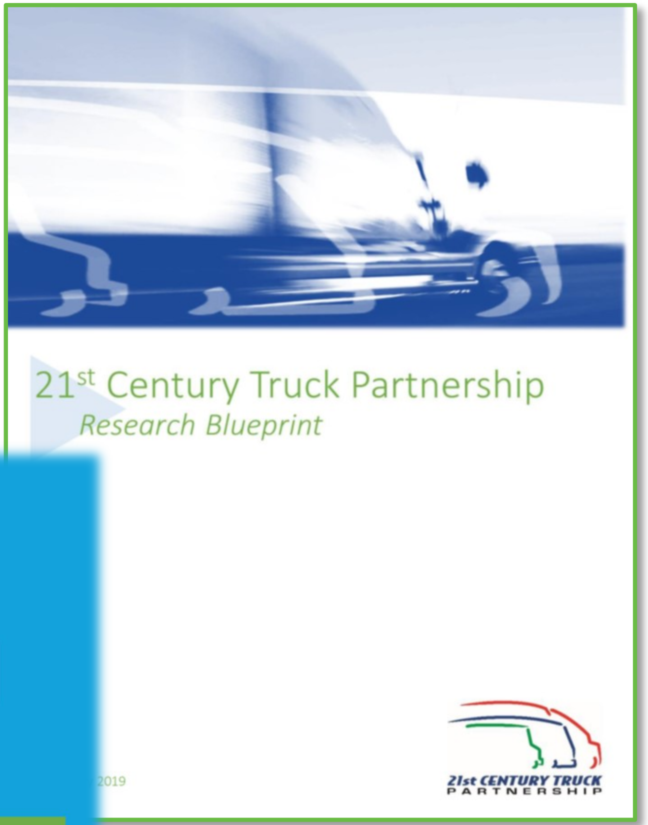
NEW IN 2019:

- Vehicle & Mobility Systems Analysis
- "e-Fuels"
- New Grid Integration Roadmap and Targets

https://www.energy.gov/eere/vehicles/us-drive

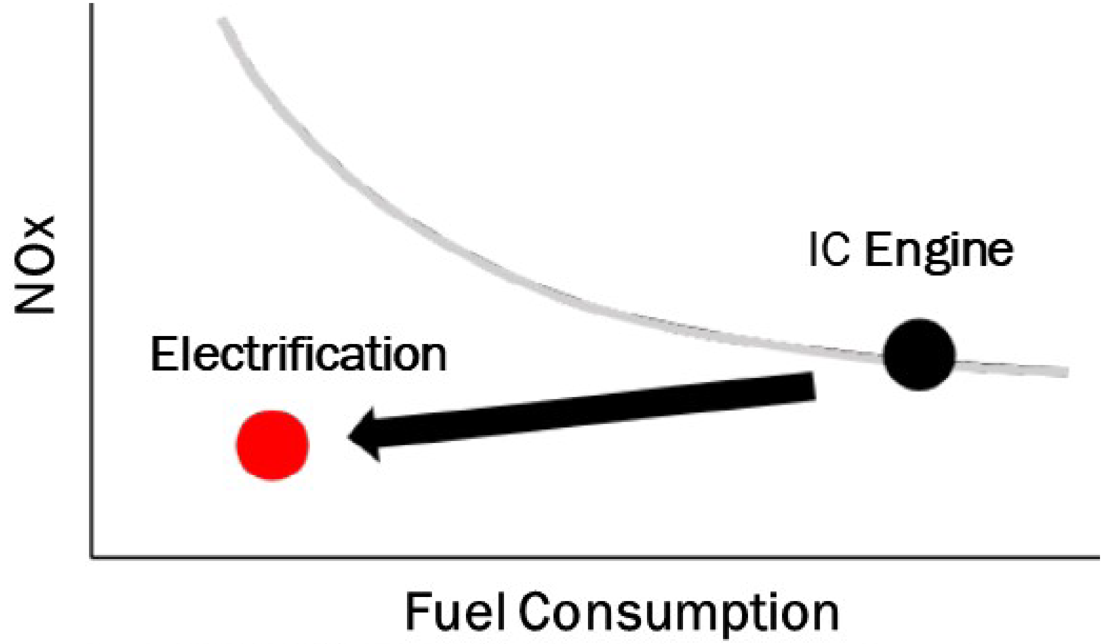
- ✓ Learn More...
- ✓ Partnership Plan and Roadmaps…
- ✓ Accomplishments Reports…

- Trucking drives the economy
- Efficient, safe vehicles and operations reduce costs for businesses and customers
- Cooperative R&D maintains U.S. competitiveness and energy security
- Eleven manufacturers
- DOE, DOT, EPA, Army
- Four tech teams with performance goals and R&D strategies



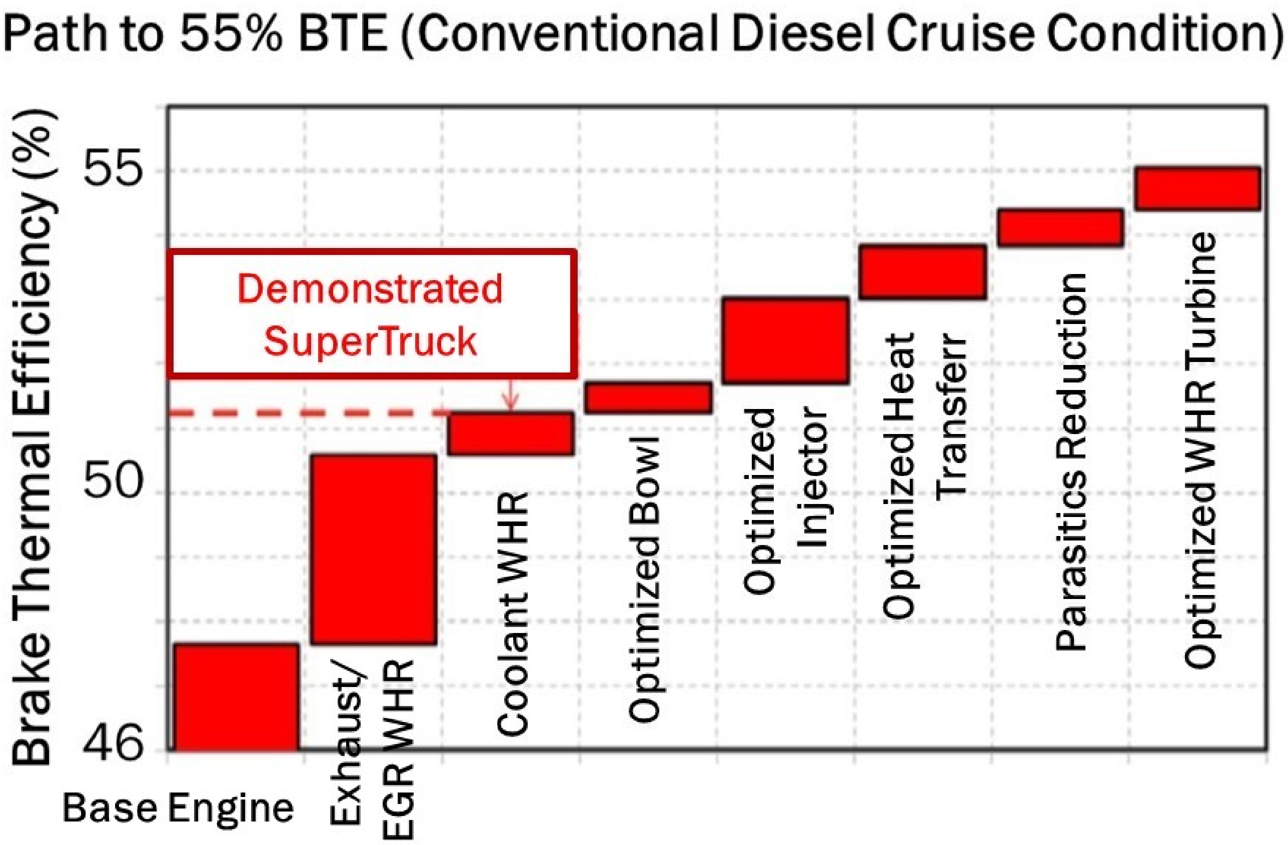
21st Century Truck Partnership Research Blueprint, February 2019

Electrification Versus IC Engines



Weight

Cost

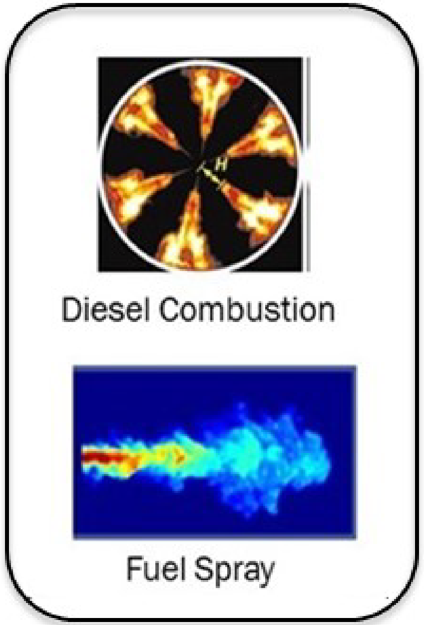


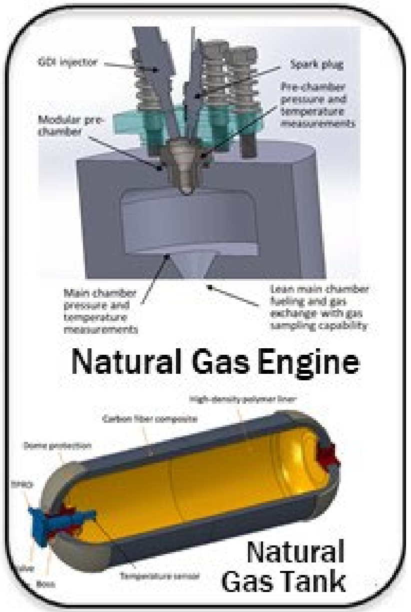
Cummins-Peterbilt SuperTruck Team's Projected Incremental Gains to 55 Percent, Source: Kocher 2014

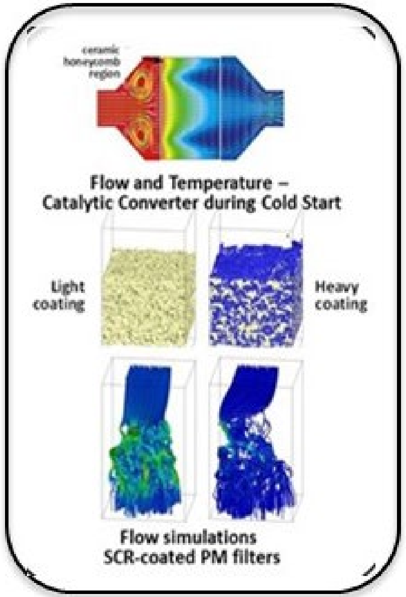
Gurpreet Singh

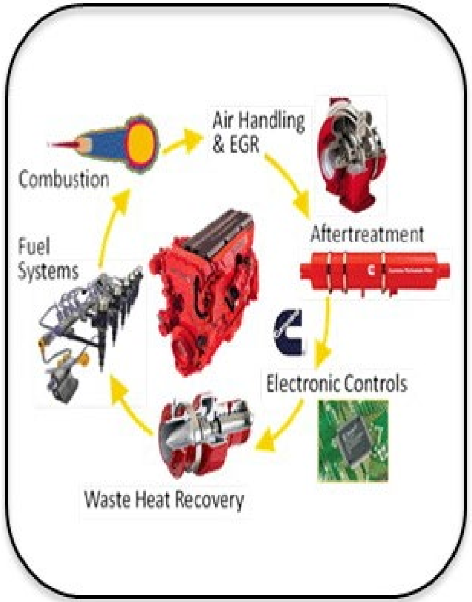
Advanced Engine and Fuel Technologies

Combustion Research	Co-Optimization of Fuels and Engines	Alternative Fuel Engines	Emission Control	High Efficiency Engine Technologies







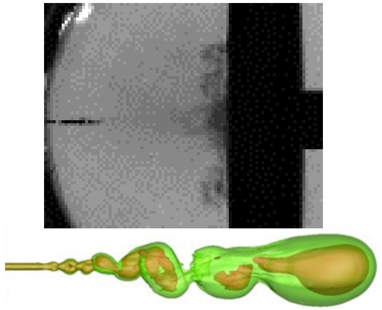


Advanced Light-Duty Combustion Consortium

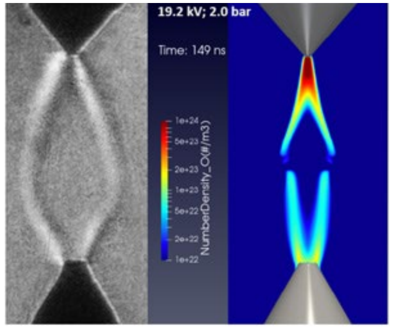
Mike Weismiller

- National lab consortium to provide the <u>data, knowledge, and tools</u> to enable the design of clean, efficient IC engines
- Remove key barriers to efficiency and emission reduction through simulation/prediction of:
  - abnormal combustion events (knock, pre-ignition)
  - cold-start emissions (including soot)
  - highly dilute combustion (including cycle to cycle variations)

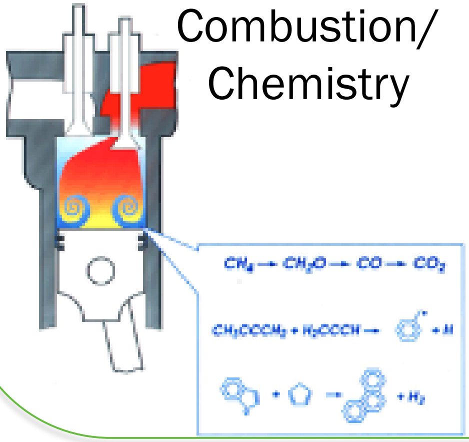
Spray/Wall Interactions



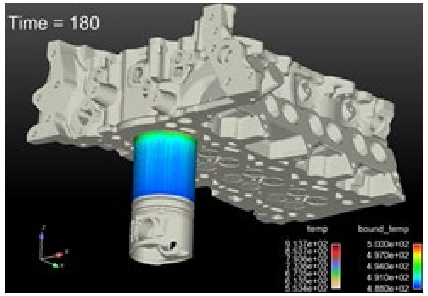
Ignition



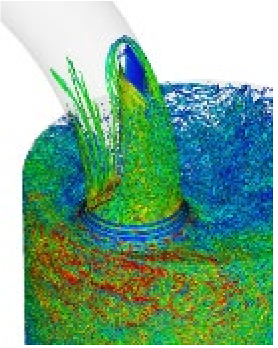
Combustion/ Chemistry



Heat Transfer



Turbulent Flow



ML/AI

High Performance Computing

(exa) - 10^{18}

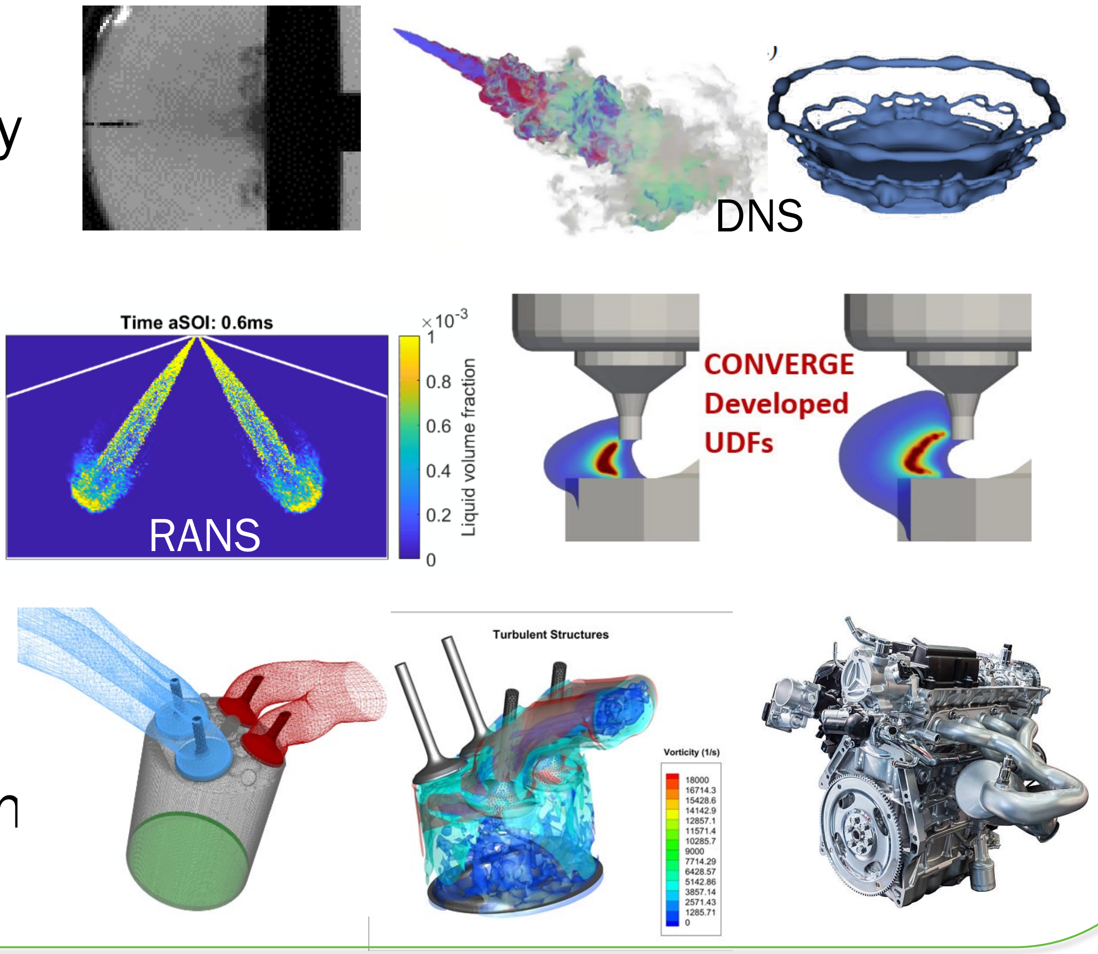
Advanced Light-Duty Combustion Consortium

Cold-start emissions

Foundational Physics/Chemistry

Model Development

Engine Simulation and Validation



Leveraging technical leadership across the national laboratories

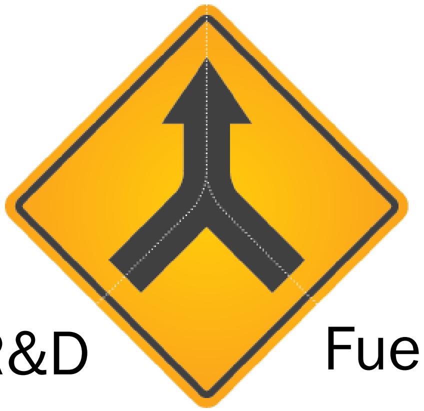
Argonne National Laboratory · Lawrence Livermore National Laboratory · Los Alamos National Laboratory · NREL · Oak Ridge National Laboratory · Sandia National Laboratories

Presentations: 8am-5pm on Tuesday in Regency E

Co-Optimization of Fuels and Engines

Kevin Stork

Objective: Advance the underlying science needed to develop fuel and engine technologies that will work in tandem to achieve significant efficiency and emissions benefits



Engine R&D

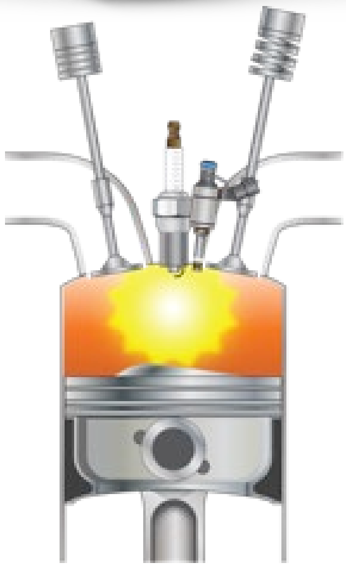
Fuel R&D

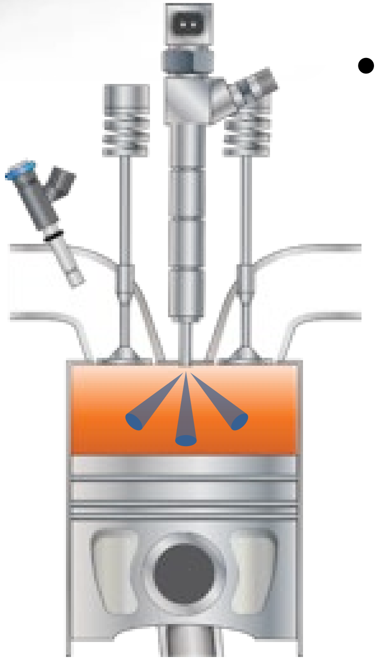
- Two DOE Offices:
  - Vehicle Technologies Office
  - Bioenergy Technologies Office
- Nine National Labs
- More than 20 university and industry partners

Co-Optima Approach

Light-Duty

- Near-term opportunity: improved efficiency consistent with the operating range of modern, downsized engines (Boosted Spark Ignition)
- Mid-term opportunity: improved efficiency across drive-cycle (Multi-Mode Spark Ignition/Advanced Compression Ignition)





Medium/Heavy-Duty

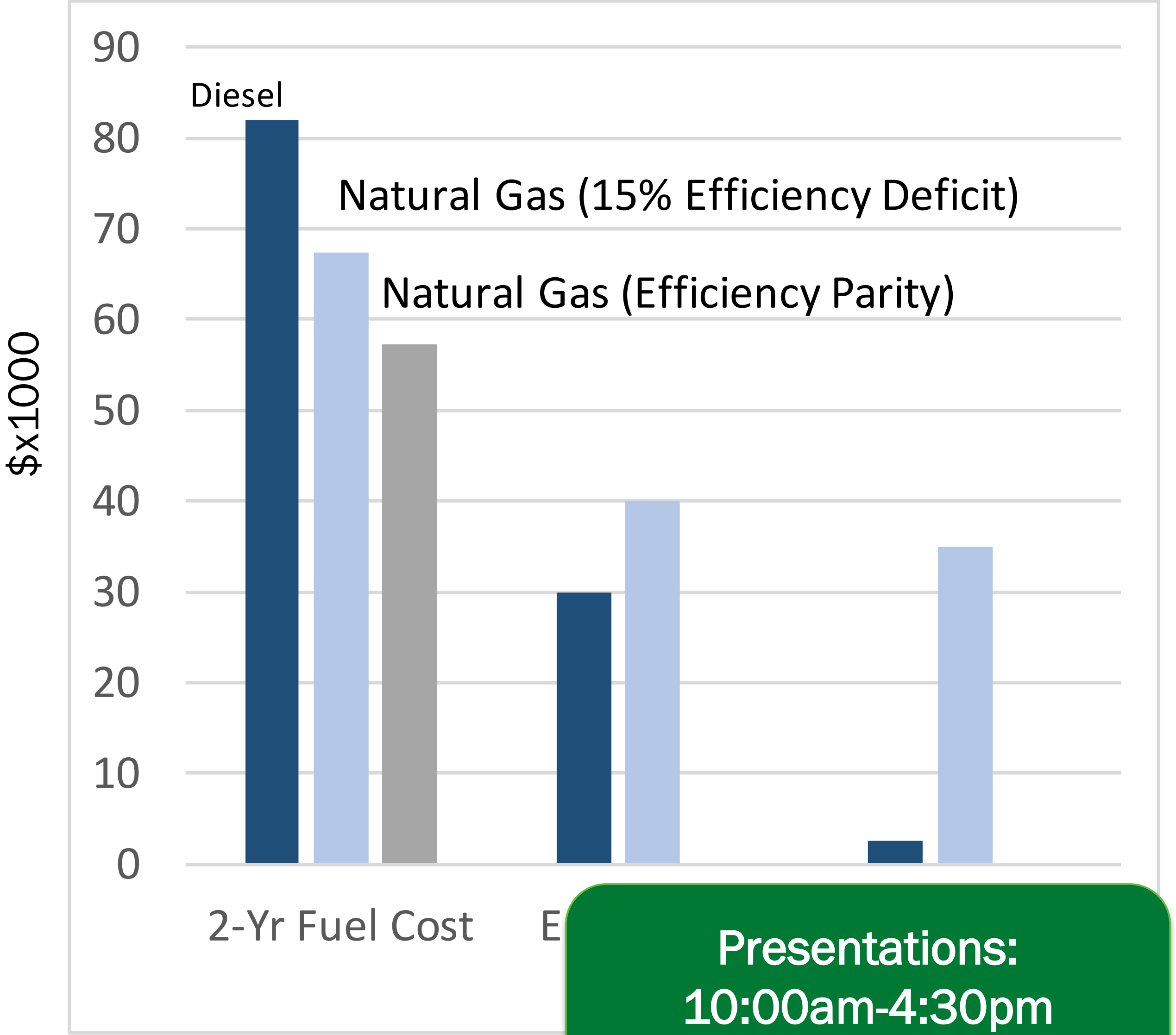
- Near-term opportunity: improved engine emissions, bio-distillate substitution (Mixing Controlled Compression Ignition)
- Longer-term, high-risk/ high-reward opportunity: improved efficiency and emissions (Advanced Compression Ignition)

Presentations:
8:30am-5:00pm
Wednesday in Regency F

What Is Holding Back More Use of Natural Gas for Transportation?

Kevin Stork

- **Fixed Costs – NG vs Diesel:**
  - Fuel Storage ($35K vs $2.5K)
  - Engine ($40K vs $30K)
  - After treatment ($2.5K vs $7.5K)
- **Running Costs on 2-Year Payback ***
  - Fuel ($67K vs $82K)
  - Fuel at Efficiency Parity ($57K vs $82K)
  - Other Costs ($3K vs $3K)
- **Other Considerations:**
  - Fuel Price Uncertainties
  - Less Torque, Less range
  - Uncertain Refueling Access
  - New Training/Maintenance Programs



* Assumptions:

- 100,000 miles per year; Class 8 diesel truck fuel economy of 7.5 MPG
- Diesel fuel price of $3.15/gallon; CNG price of $2.18/GGE

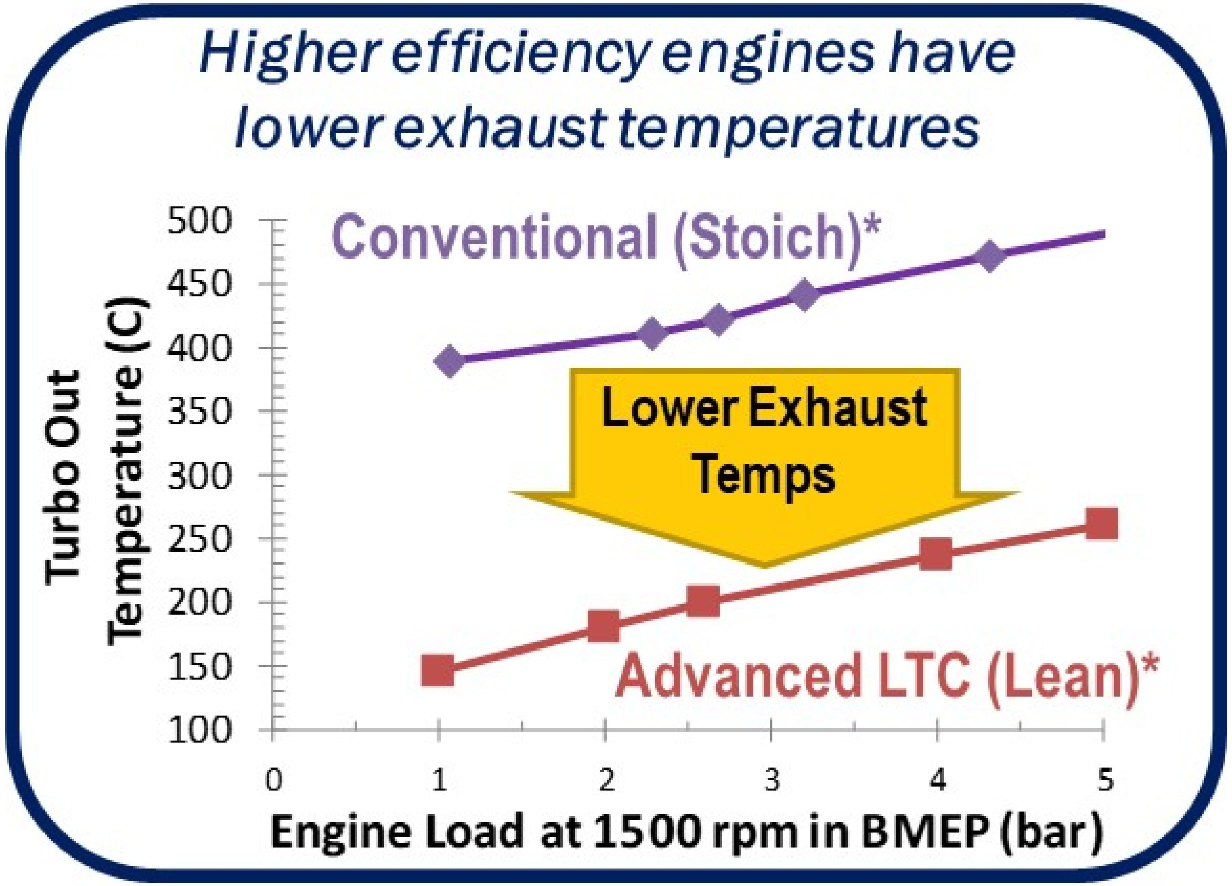
Presentations:
10:00am-4:30pm
Thursday In Regency F

Fuel Efficiency and Emissions Interlinked

Ken Howden

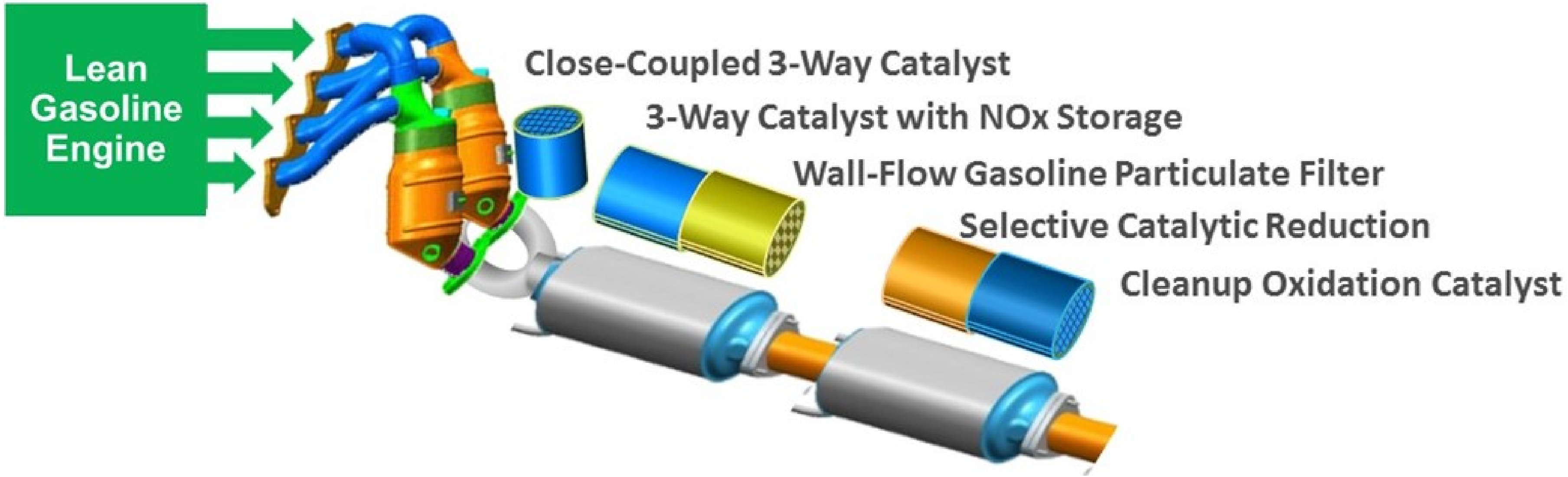
more efficient engines = lower exhaust temps = catalyst challenges

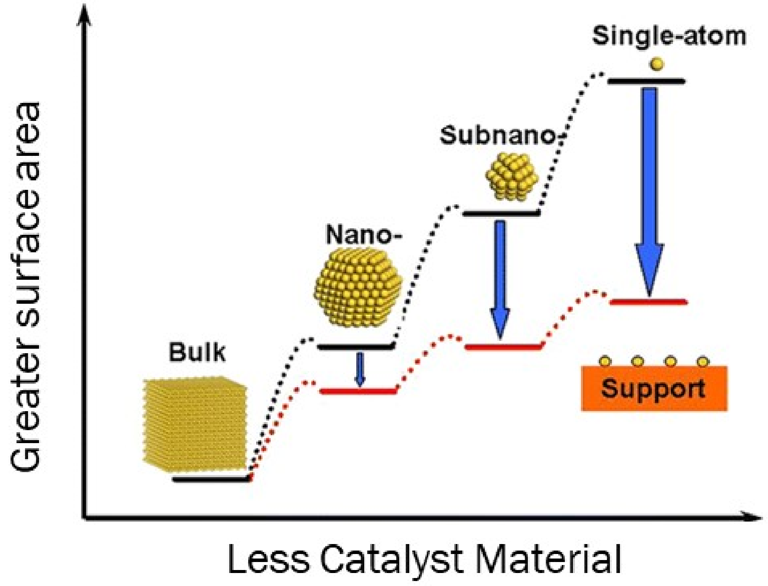
- Greater combustion efficiency lowers exhaust temperature
- Catalysis is challenging at low temperatures
- Fuel economy standards are going up
- Emissions standards getting more stringent

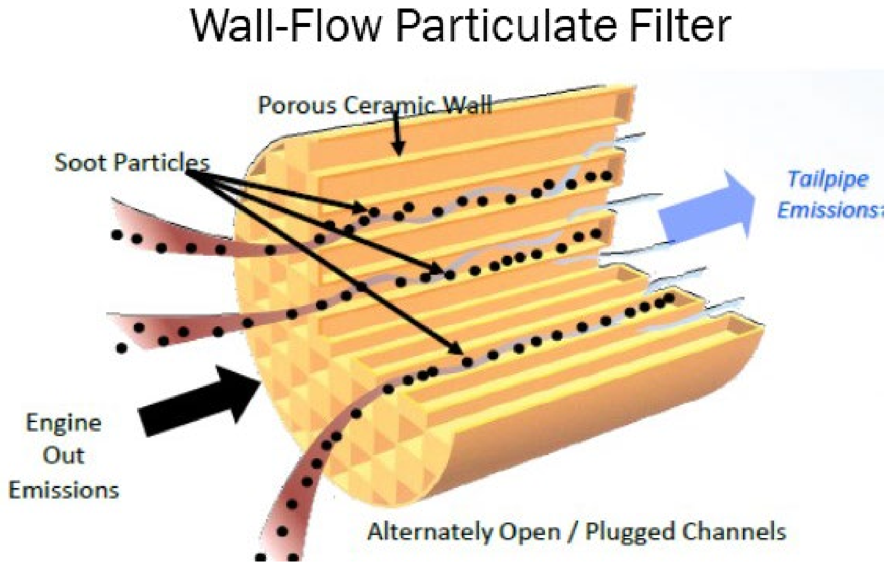


*"**Conventional**": modern state-of-the-art Gasoline Direct Injection Turbocharged stoichiometric-burn engine vs.
"**Advanced LTC**": Reactivity Controlled Compression Ignition (RCCI) [an advanced lean-burn Low Temperature Combustion (LTC) engine]

Emission Control for Future Engines and Fuels



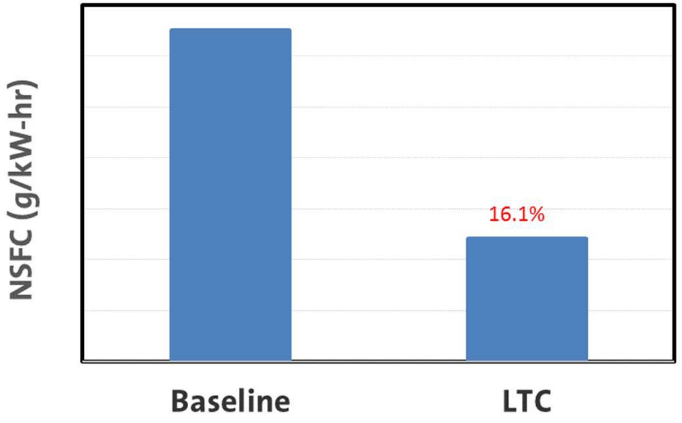


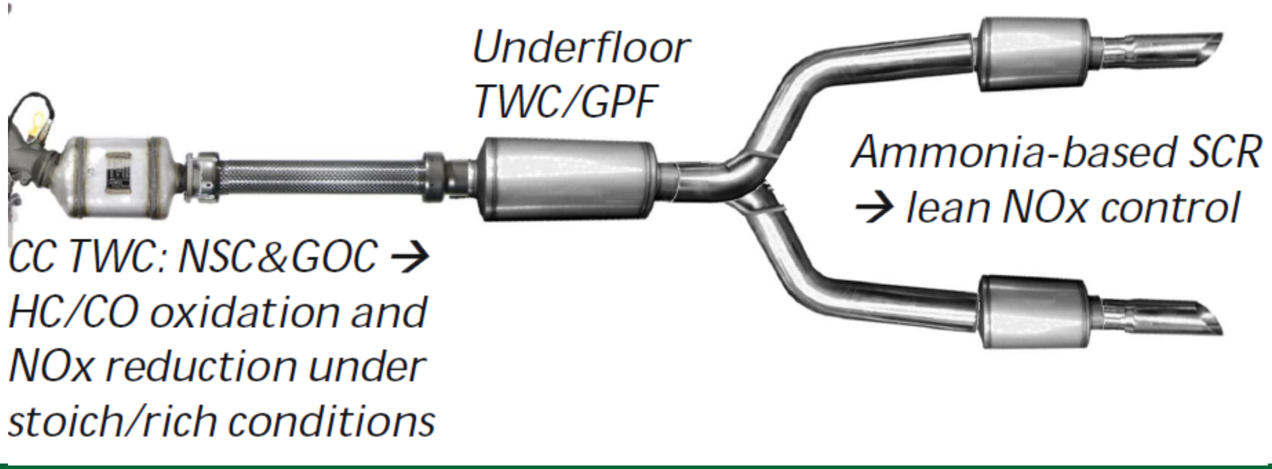


A High Specific Output Gasoline Low-Temperature Combustion Engine – General Motors

Develop a high-output, low-temperature gasoline combustion engine system demonstrating a 15% to 17% fuel economy improvement relative to a contemporary stoichiometric combustion engine.

- Gasoline low temperature combustion system combined with downsizing and boosting
- Low temperature plasma ignition system
- Physics-based model-based control
- PASS (Passive-Active Ammonia SCR) lean NOx aftertreatment system
- Key Suppliers: FEV, Delphi, Honeywell, BMTS, Federal Mogul, BASF





Improve Fuel Economy with Lightweight and Propulsion Materials

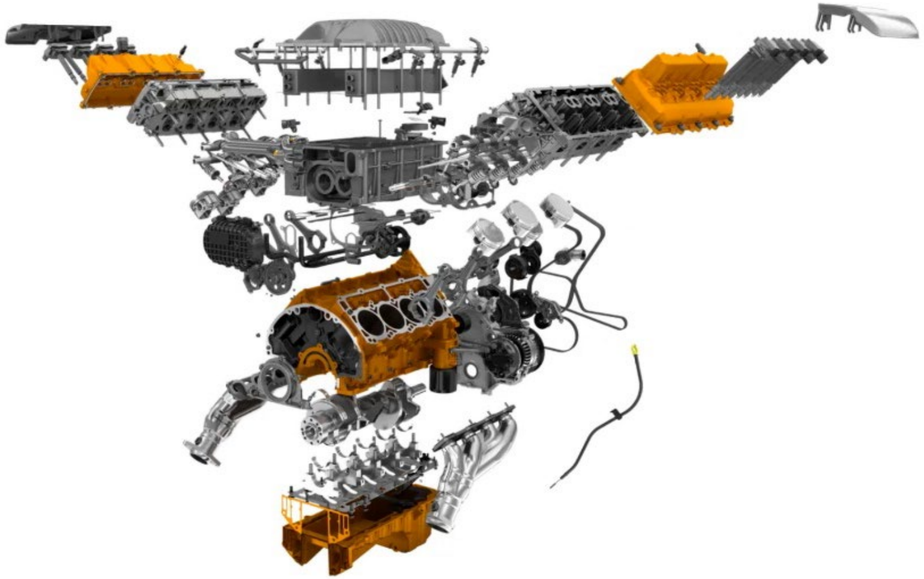
Gurpreet Singh

Lightweight Materials

- Sheet Metals (Al, AHSS, Mg)
- Carbon Fiber Composites
- Multi-Material Joining

Propulsion Materials

- Cast Metals (Al, Cast Iron, Stainless)
- High Temp Alloys (500 – 1100 C)



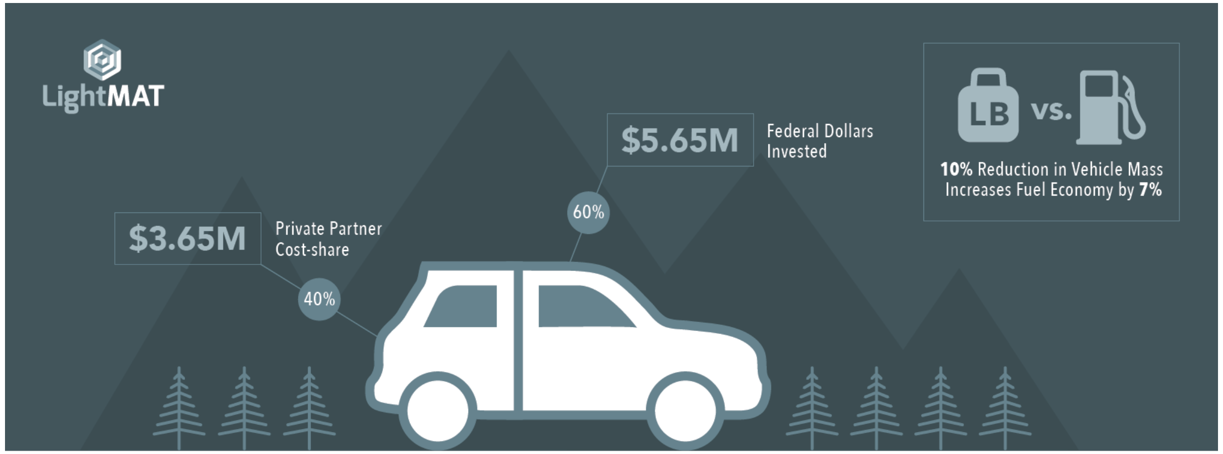
Program Goals: 25% glider weight reduction at less than \$5 / lb-saved by 2025 and 25% improvement in high temperature component strength by 2025.

LightMAT: A Multi-Lab Consortium for Accelerating Lightweight Materials Development

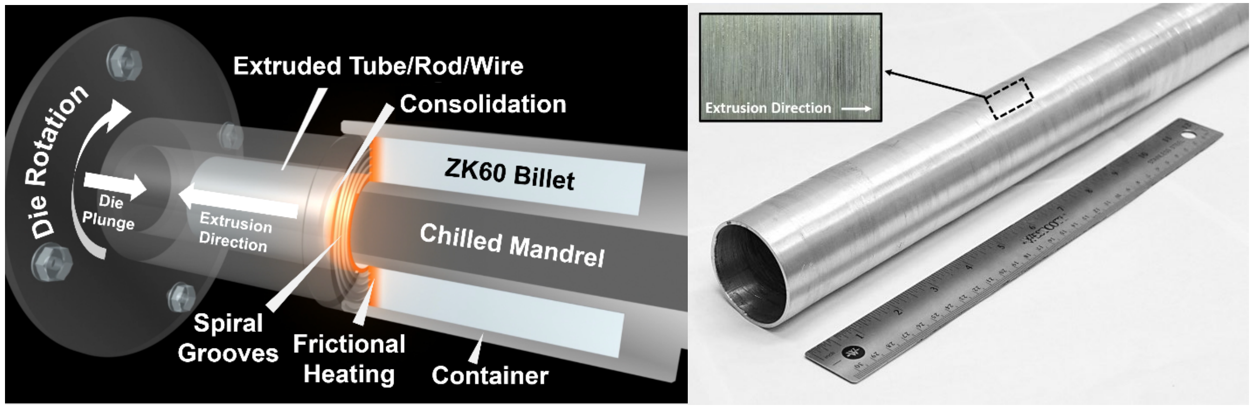
Sarah Kleinbaum

Objective: Facilitate connections between industry and National Lab resources to accelerate lightweight materials development and provide access to unique scientific and technical resources such as:

- high resolution and non-destructive characterization,
- novel synthesis and processing of materials,
- and high-impact predictive modeling.



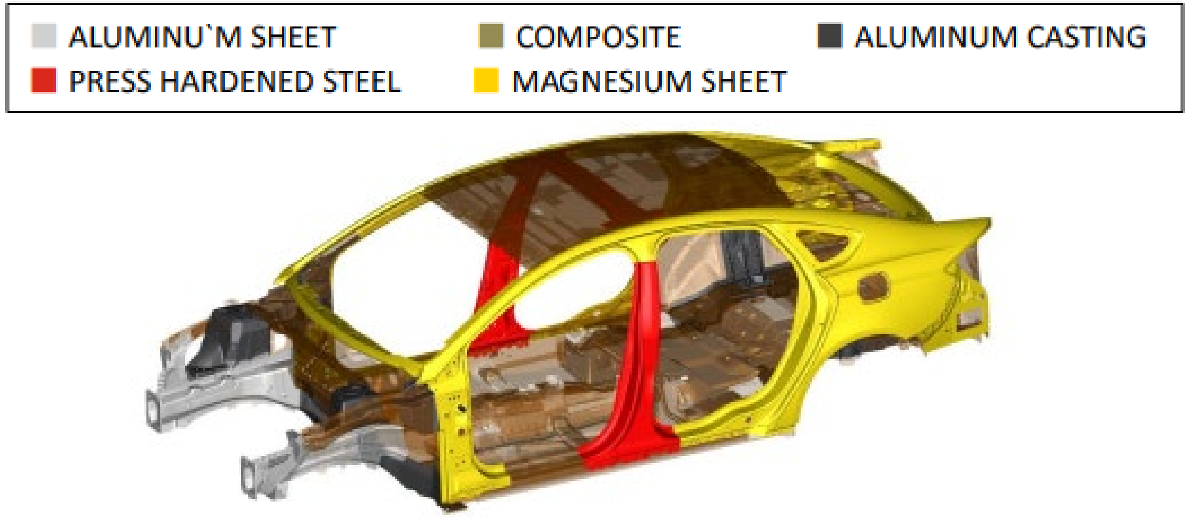
11 National Laboratories | **14** Partner Organizations | **142** Cross Network Capabilities | **13** Total Projects



PNNL's ShAPE Process and ZK60 Extruded Tube

www.LightMAT.org

Joining Difficult Dissimilar Material Pairs at PNNL & ORNL



The lightest weight vehicles will be made from a mix of Advanced High Strength Steel, Aluminum, Magnesium, and Polymer Composites

Thrust 1: Magnesium to Advanced High Strength Steel

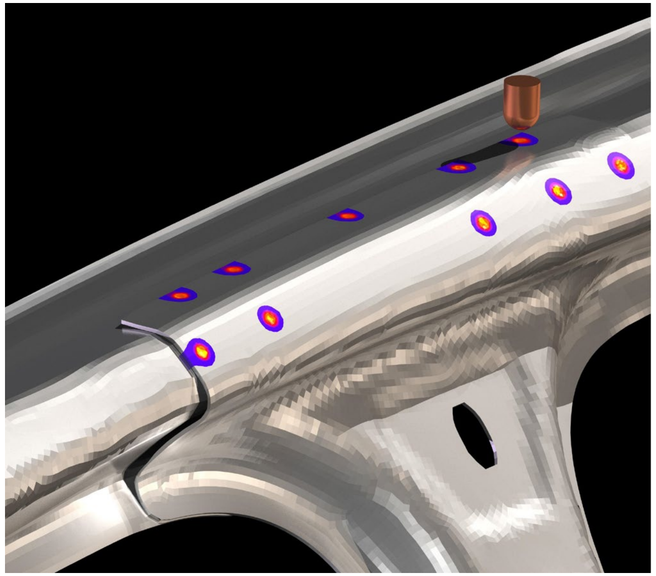
- Friction Stir Scribe Welding (PNNL)
- Ultrasonic Welding (ORNL)

Thrust 2: Advanced High Strength Steel to Carbon Fiber Composites

- Adhesives (ORNL / PNNL)

Thrust 3: Carbon Fiber Composites to Magnesium

- Friction Stir Interlocking (PNNL)
- Friction Self Pierce Riveting (ORNL)



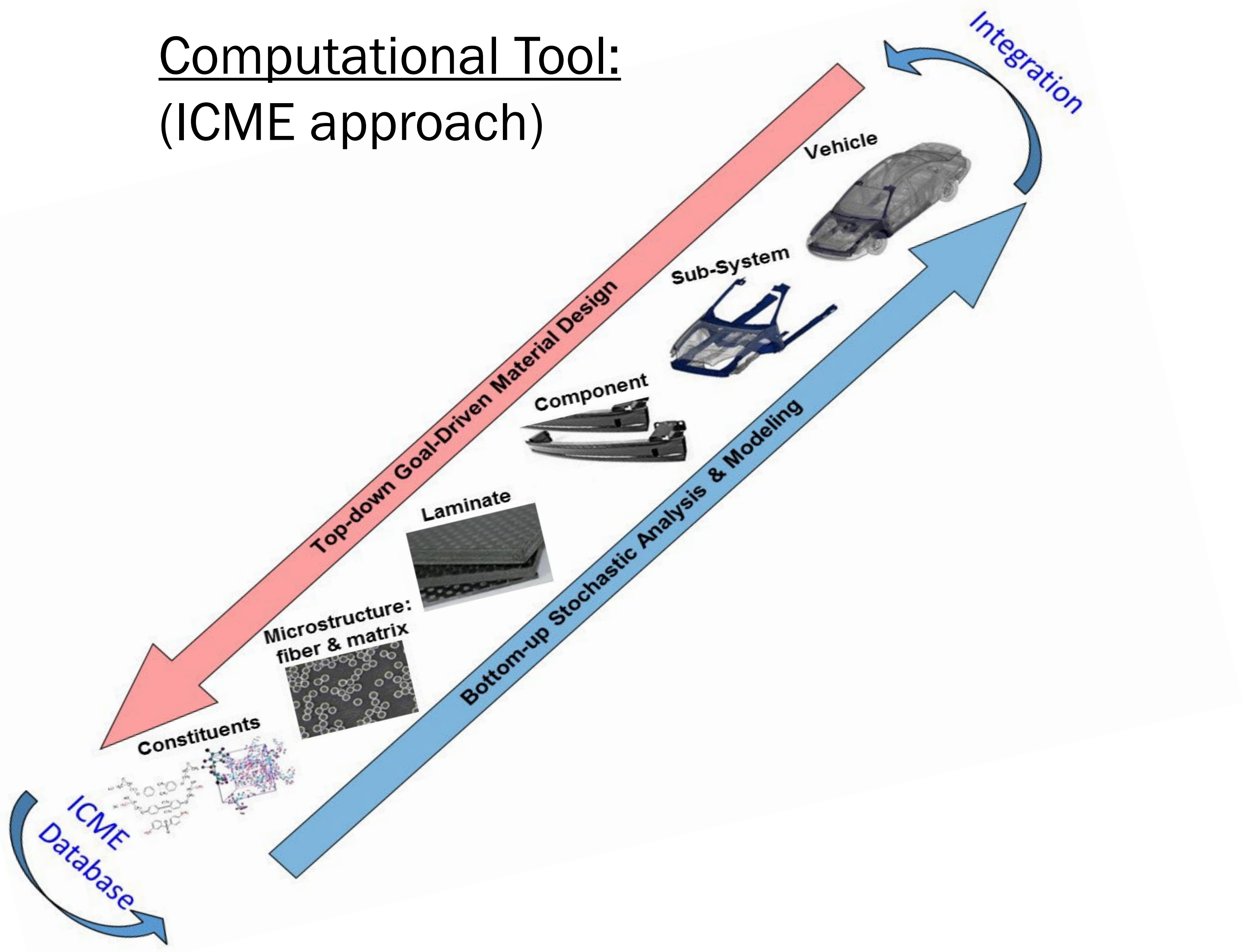
Cross-cutting efforts on: Design of interfaces using multiscale computational modeling, galvanic corrosion characterization and mitigation, and in-line process control

Carbon Fiber Composites

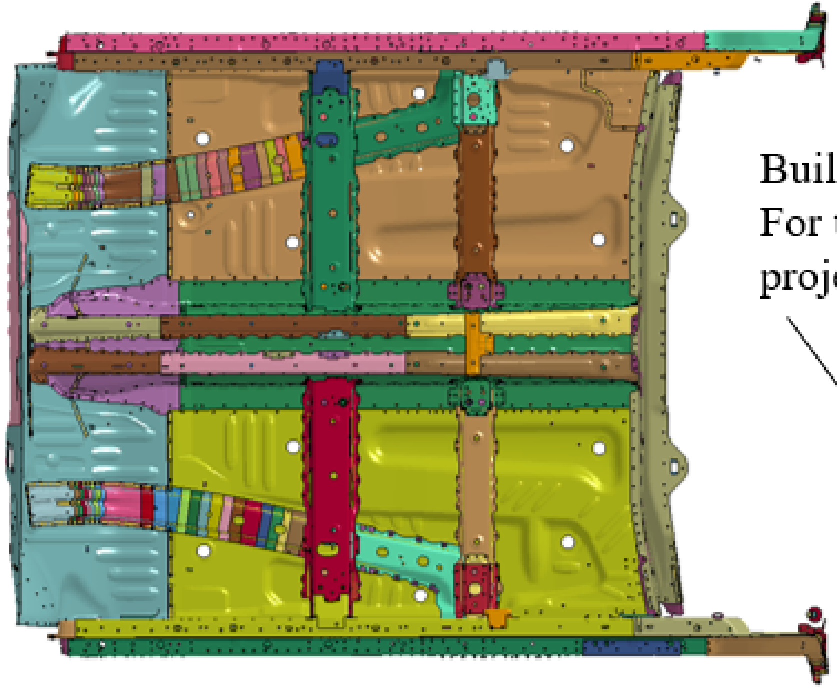
H. Felix Wu

- **Opportunity**: Significant weight reduction for fuel economy improvement through application of high specific strength and high specific stiffness composites
- **Issues**: High raw material cost, computational tools capable of accurate predictions with validation not been developed
- **Approach**: Integrate manufacturing with structural performance models using Integrated Computational Materials Engineering (ICME) approach

<u>Computational Tool:</u>
(ICME approach)

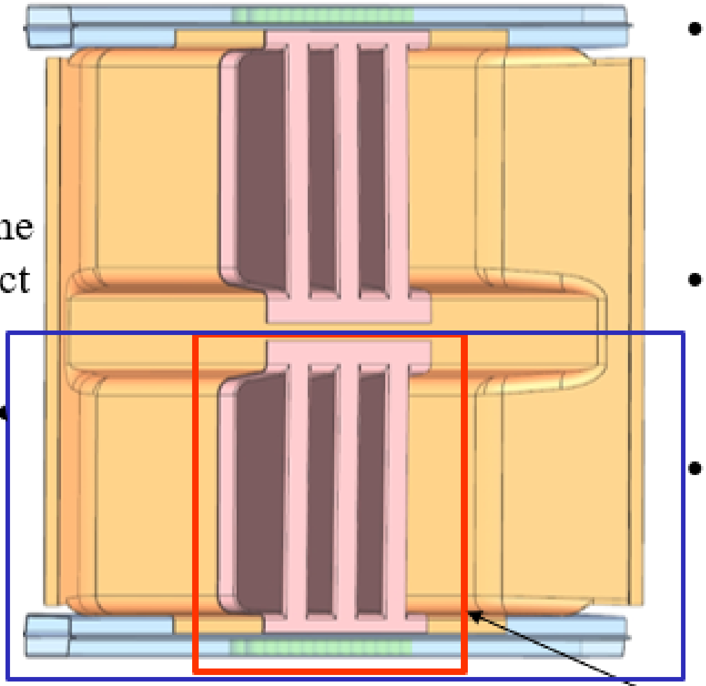


Carbon Fiber Composites



Built
For the
project

2016 GM-Malibu Best in its Class
Light Weight Steel
Rocker Floor Assembly
Weight = 68 Kg



Replacement Carbon Fiber
Assembly Weight = 48 Kg

Portion of the
assembly built
for the prototype
evaluation

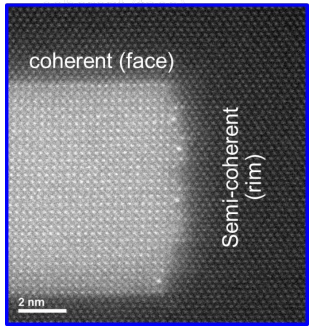
- Parts consolidation from 81 steel parts to 9 composite parts
- Carbon fiber design is 30% lighter than steel
- Further optimization is expected to improve the weight savings to ~ 40%

Accelerated Development of Tailored Aluminum Alloys

Jerry Gibbs

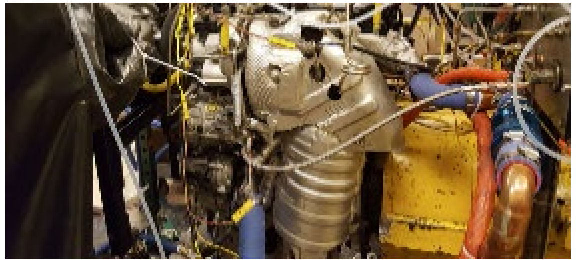
Integrated Approach

- Advanced Characterization



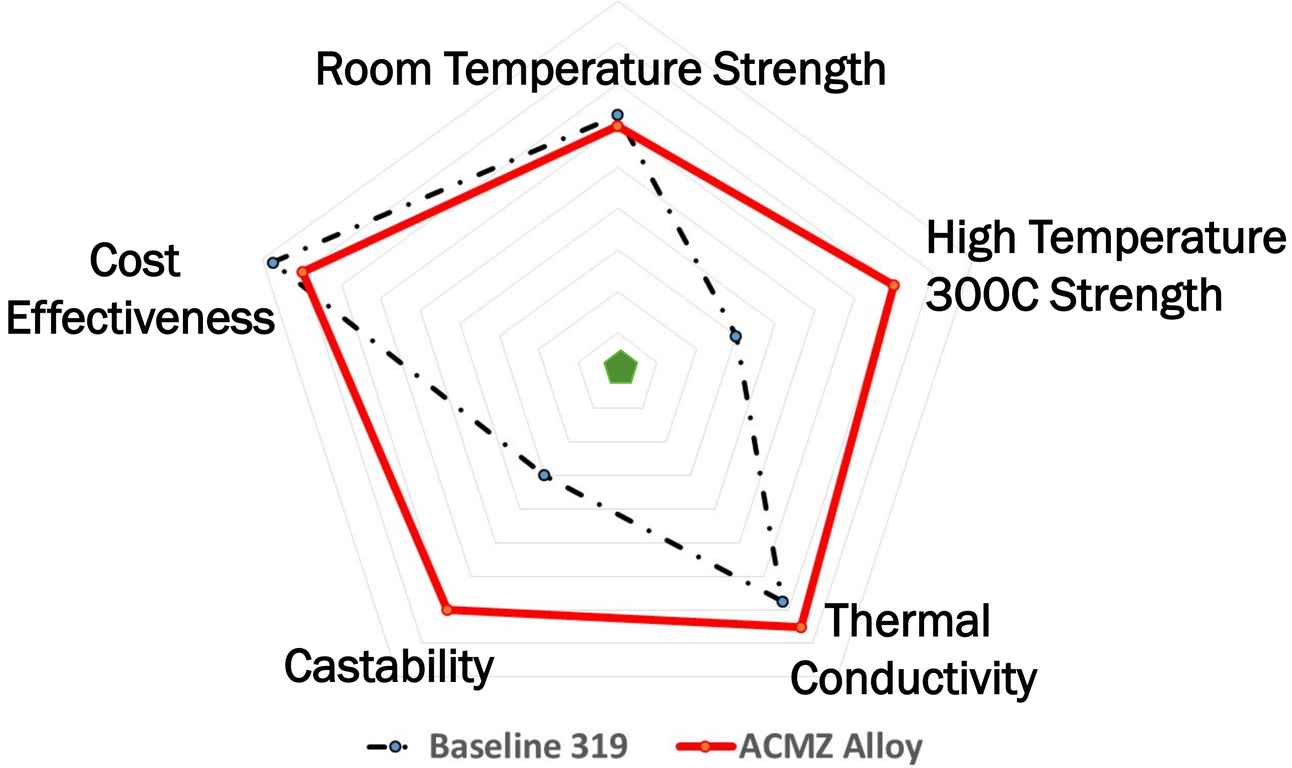
- Modern Computational Materials/HPC

- Multi-scale experimental validation



Results

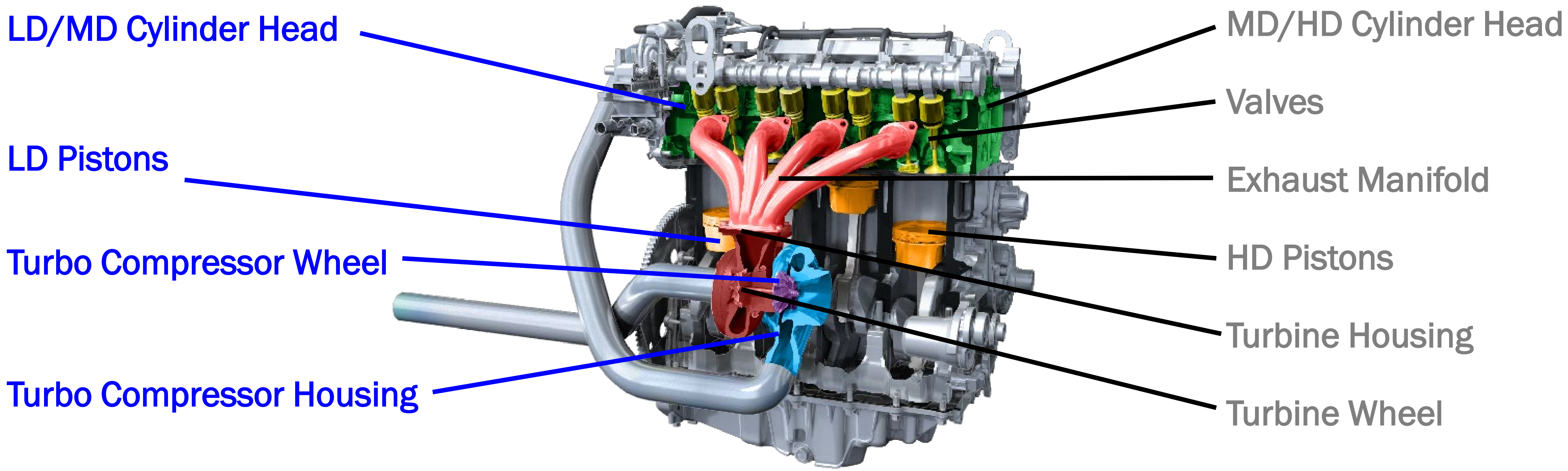
- 1st Generation ACMZ Al. alloy with Tailored Properties



* Further from center indicates better performance

- >50% Improvement in High Temperature Strength
- >50% reduction Development Time

The Powertrain Materials Core Program
Address Critical Powertrain Component Materials Needs



Thrust 1. High Temperature Lightweight Alloys <500C (low – mid TRL)

Thrust 2. Higher Temperature >500C (Ni-, Fe-based) Alloys (low - mid TRL)

Panel 2 – Batteries and Electrification

Steven Boyd, Program Manager, Batteries and Electrification

Brian Cunningham, Technology Manager

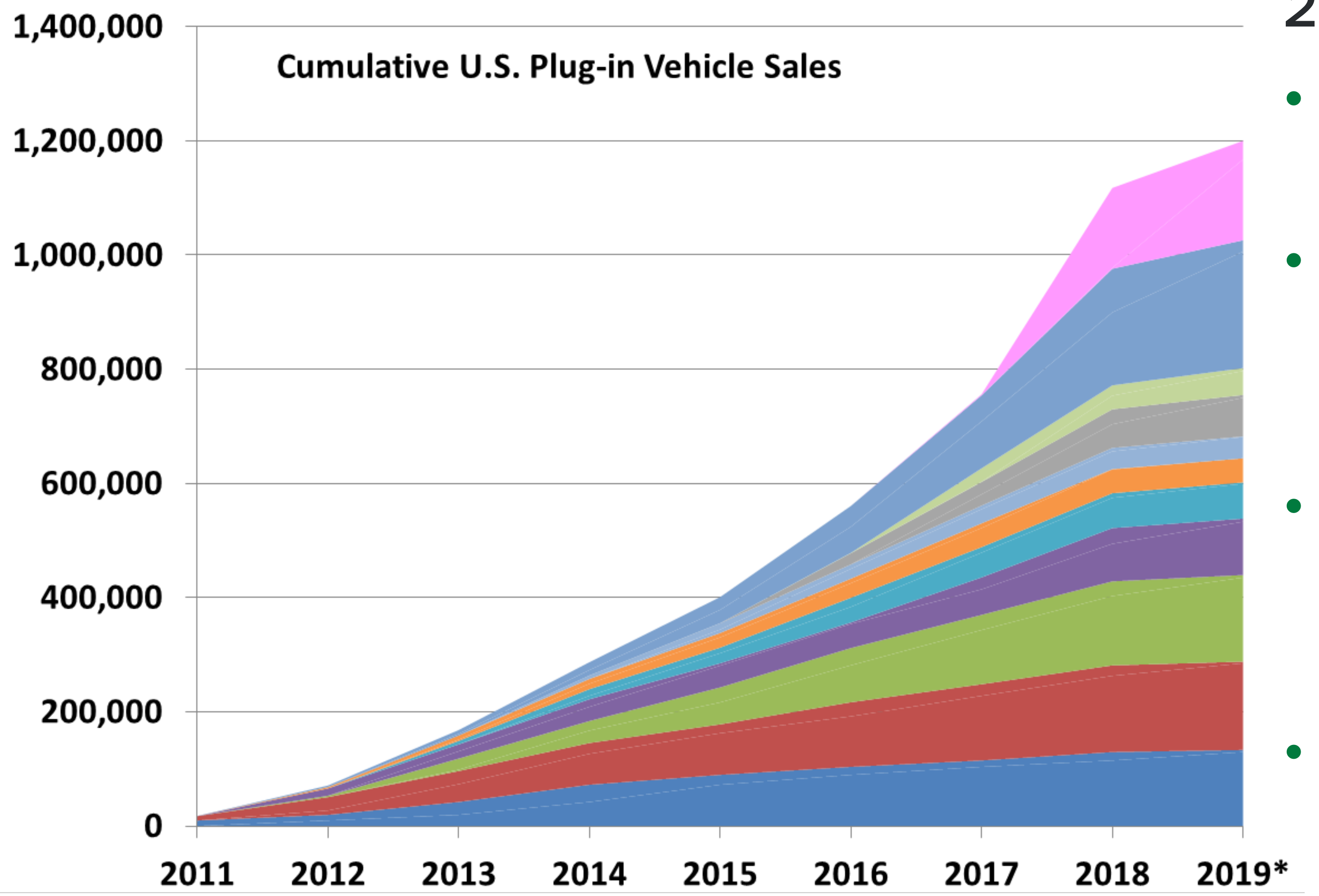
Peter Faguy, Technology Manager

Samuel Gillard, Technology Manager

Tien Duong, Technology Manager

Susan Rogers, Technology Manager

Lee Slezak, Technology Manager



Yan Zhou, Argonne National Laboratory
*Through March 2019

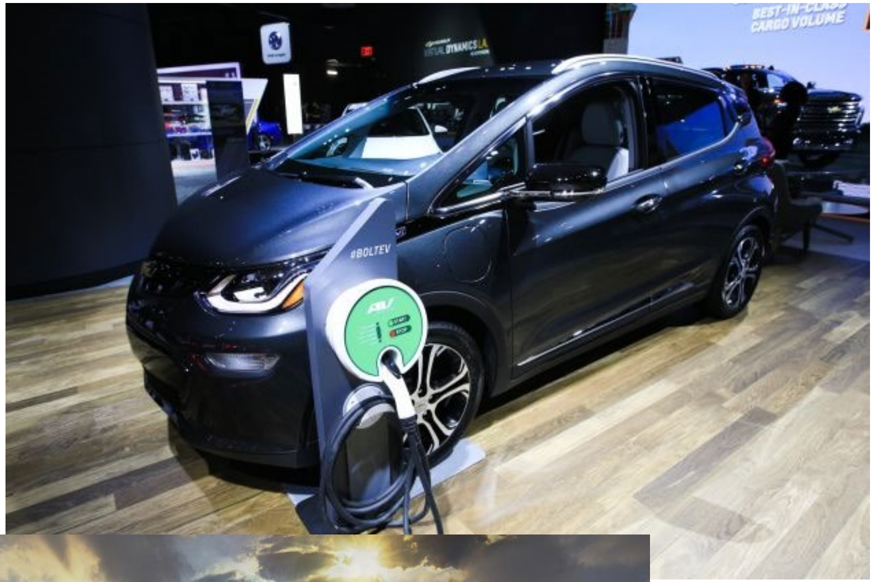
IEA (2019), "Global EV Outlook 2019", IEA, Paris

2019 IEA Global EV Outlook

- In 2018, the global electric car fleet exceeded 5.1 M, up 2 M
- 2030 New Policies Scenario:
  - Global EV sales reach 23 M
  - Stock exceeds 130 M vehicles
- EV30@30 Scenario:
  - Global EV sales reach 43 M
  - Stock exceeds 250 M
- Support for battery manufacturing and solid state batteries
- Simpler architectures for EVs with compact electric motors

Batteries and Electrification – Introduction

- New York International Auto Show: more than 40 electrified vehicles
- EPRI: Utilities are proposing ~$3.7B in EV charging infrastructure
- Continental CEO: Next 15 years, in the powertrain arena “the train is out of the station” in transformation to electrification
- CEO of Daimler Trucks North America: For commercial vehicles “The beginning of the post internal combustion engine era”

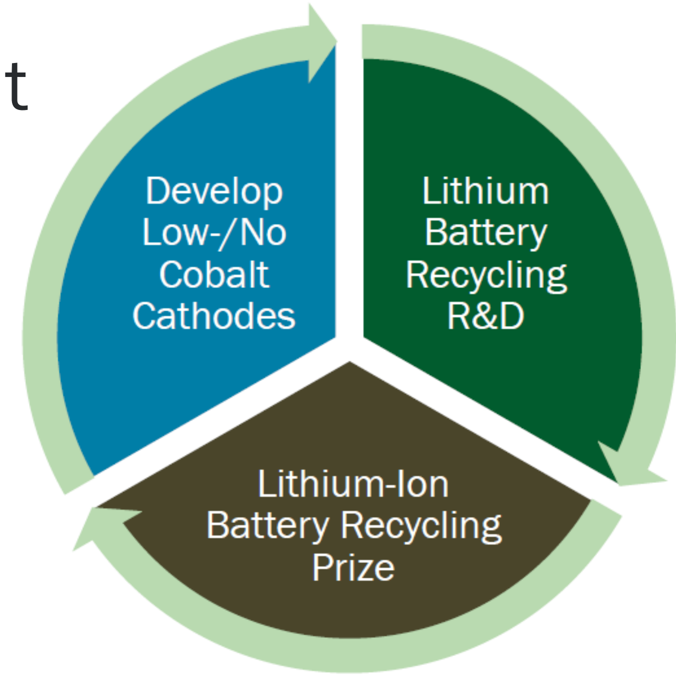


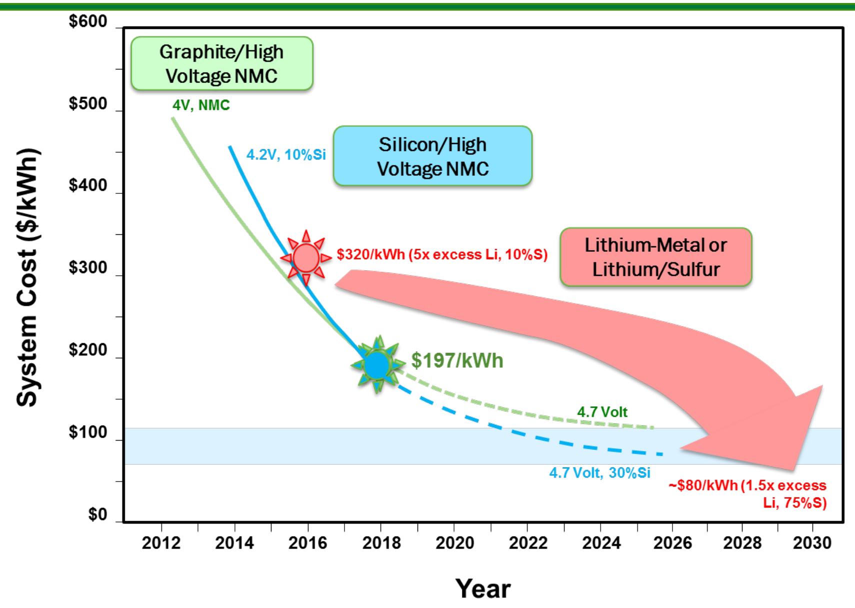
2020 Chevy Bolt | Adam Jeffery | CNBC

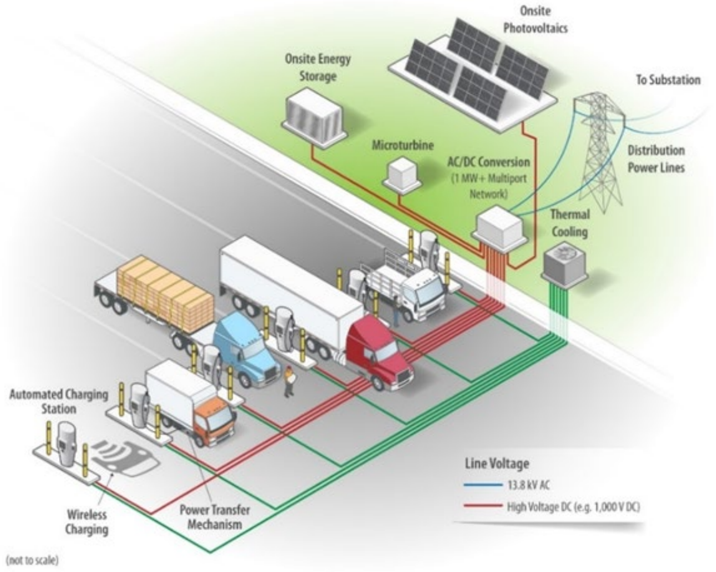
https://www.cummins.com/news/2018/04/23/cummins-puts-electrification-progress-display

Batteries and Electrification – Introduction

- **Affordable**
  - Battery and Electric Drive System Costs
  - Charge Management
- **Secure**
  - Cybersecurity
  - Materials supply and recycling
- **Reliable**
  - Localized, behind the meter storage
  - Vehicles powered from grid electricity







Energy Storage: Battery Cost Story – The Past and Future

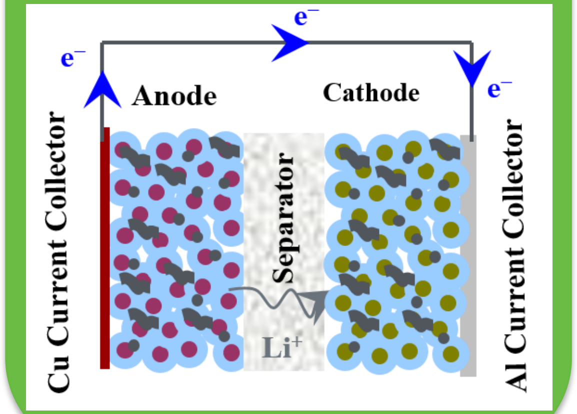
Brian Cunningham

CHARTER: Develop battery technology that will enable large market penetration of electric drive vehicles

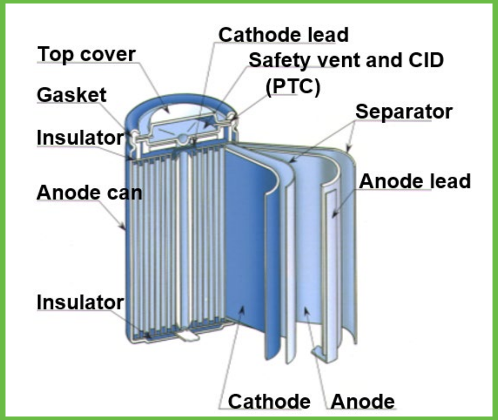
2022 GOAL: \$150/kWh$_{(useable)}$
Critical materials-free with recycled materials and capable of fast charge

Energy Storage R&D

Battery Materials Research (BMR)

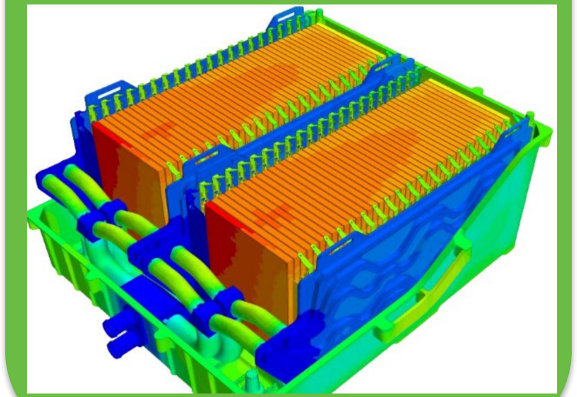


Applied Battery Research (ABR)



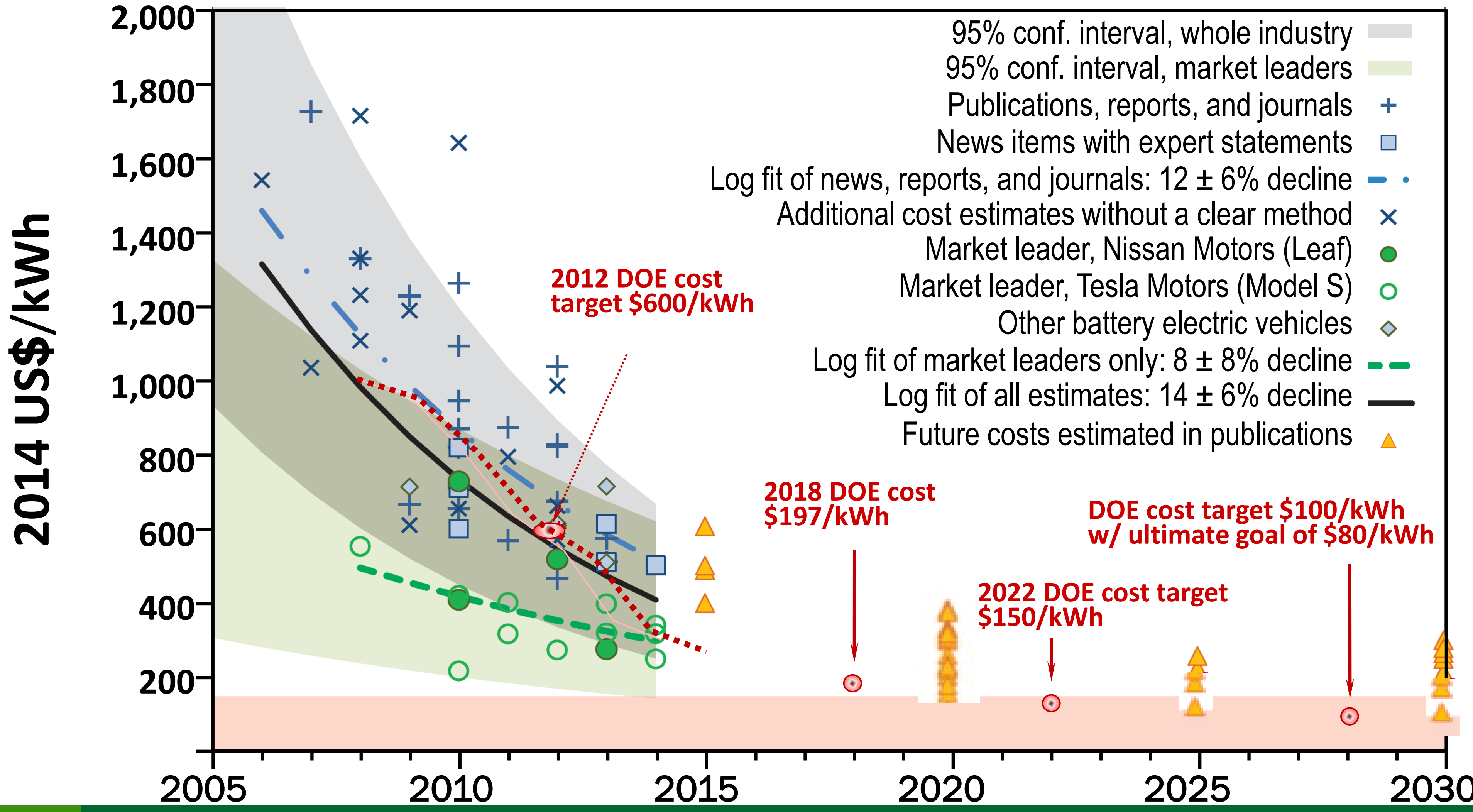
Battery Development

Battery Testing, Design, & Analysis

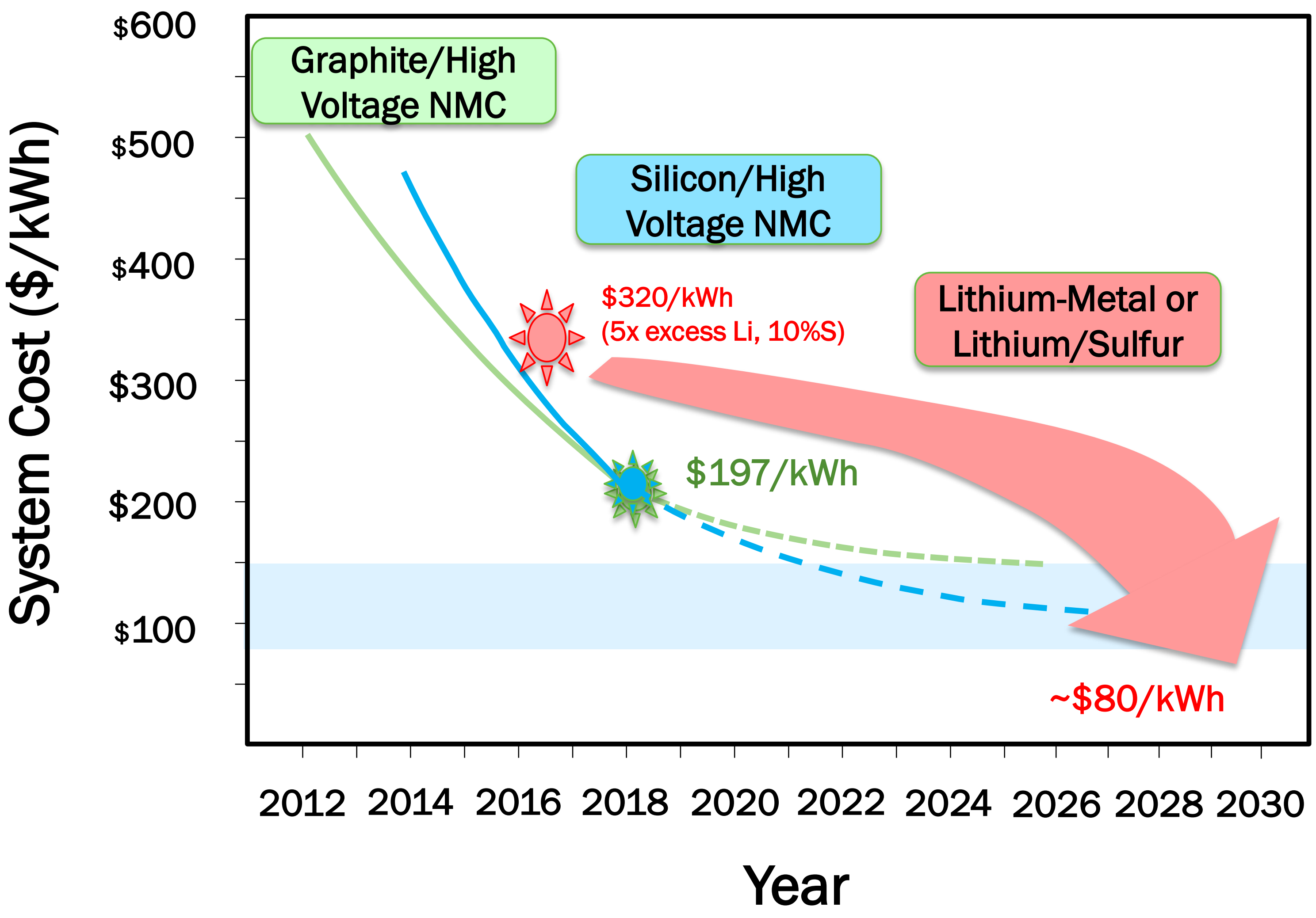


Energy Storage: Battery Cost Story – The Past and Future

"**Rapidly falling costs of battery packs for electric vehicles**", B. Nykvist and M. Nilsson; *Nature, Climate Change;* March 2015, DOI: 10.1038/NCLIMATE2564



Energy Storage: Battery Cost Story – The Past and Future



Graphite/High Voltage NMC

- R&D Focus: Higher cathode capacity (220+ mAh/g), low/no cobalt, recycling, fast charge

Silicon/High Voltage NMC

- R&D Focus: Higher anode capacity (1000+ mAh/g), cycle/calendar life, fast charge

Lithium-Metal & Li/Sulfur

- **R&D Focus: Solve cycle life/ catastrophic failure issues, reduce excess lithium, reduce excess electrolyte, reduce lithium metal cost**

Cathode Materials for Next-Generation Lithium Ion Batteries

Peter Faguy

NG LiBs require improvements in transition metal oxide (TMO)-based cathode materials

TMO cathodes are used in nearly all advanced energy and power applications

$Li^+ + e^-$ goes into the TMO	*DISCHARGING {LOWER VOLTAGE}*
$Li^+ + e^-$ comes out	*CHARGING {HIGHER VOLTAGE}*

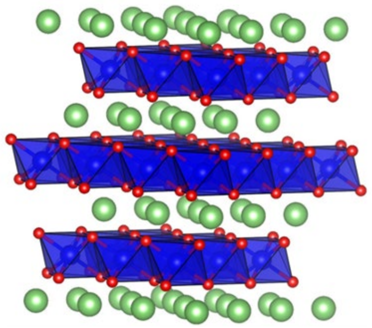
GOALS

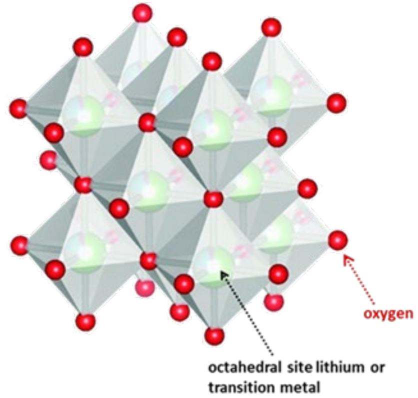
- lower Cobalt content
- improve higher voltage operation
- keep energy density high

ACTIVITIES

Four project groups, > 20 active projects across six national labs, with > $15M in FY19 funding

1. *No or Low-Cobalt Content (FOA awards)*
2. *Improve Current TMO Materials (Consortium)*
3. *Prove New Class of TMOs Viable (Consortium)*
4. *Understand Cathode/Electrolyte Interfaces (Projects)*



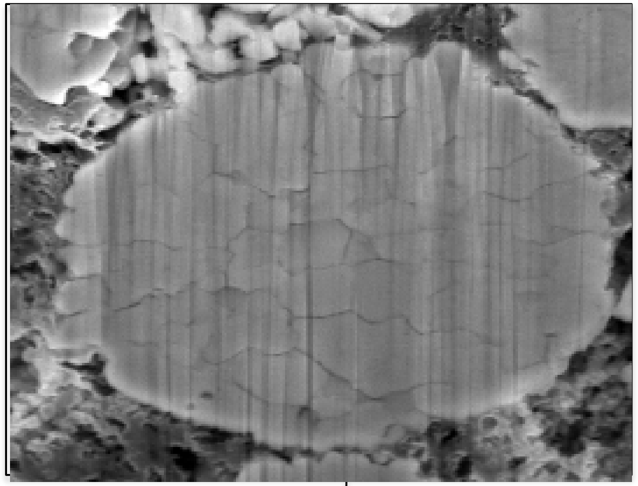


ORAL PRESENTATIONS Tues., June 11th; 8 am – noon in Potomac

POSTER SESSION Tues., June 11th; 5:30-7:30 PM in Independence A

eXtreme Fast Charge Cell Evaluation of Lithium Ion Batteries

Samuel Gillard



Particle Cracking

Argonne NATIONAL LABORATORY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

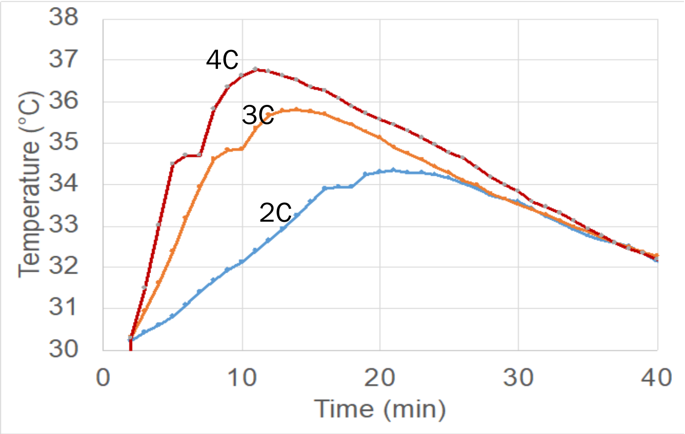
BERKELEY LAB

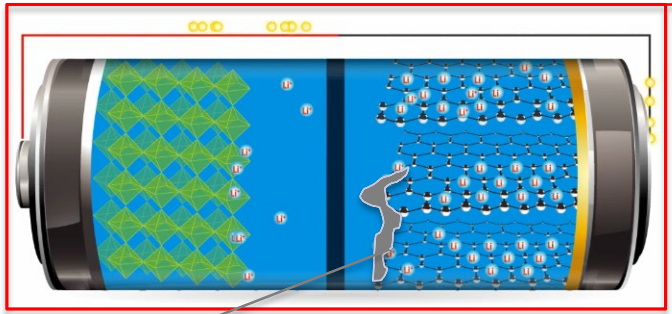
XCEL eXtreme Fast Charge Cell Evaluation of Lithium-ion Batteries

INL Idaho National Laboratory

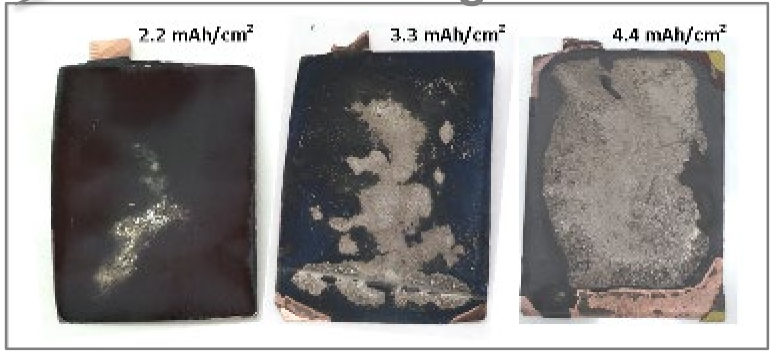
SLAC NATIONAL ACCELERATOR LABORATORY

Heat





Lithium Plating



Presentations
Room: Potomac
From 8:30-12:30

Lithium Ion Battery Recycling R&D Center

MISSION: Minimize the cost of recycling lithium ion batteries to ensure future supply availability of critical materials and decrease energy usage

ReCell ADVANCED BATTERY RECYCLING

Argonne NATIONAL LABORATORY

NREL NATIONAL RENEWABLE ENERGY LABORATORY

OAK RIDGE National Laboratory

Michigan Technological University

WPI

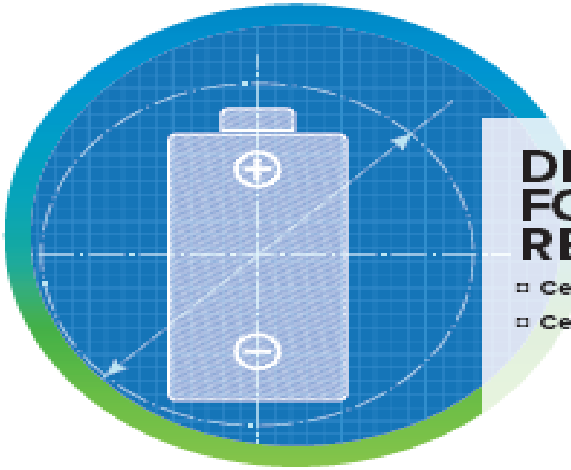
UC San Diego

DIRECT CATHODE RECYCLING

- Cathode Separation
- Binder Removal
- Relithiation
- Compositional Change

OTHER MATERIAL RECOVERY

- Electrolyte
- Graphite
- Foil

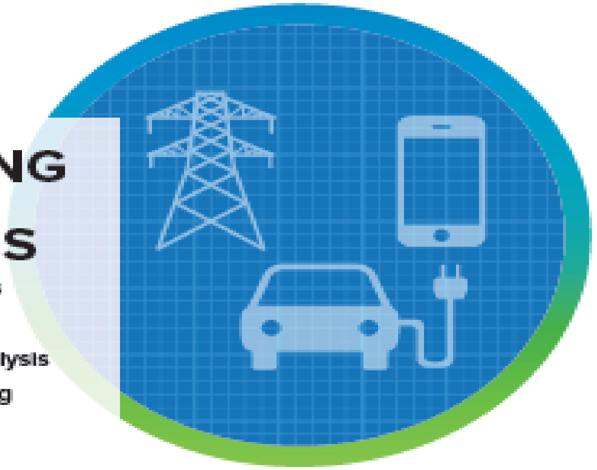


DESIGN FOR RECYCLING

- Cell Design
- Cell Rejuvenation

MODELING AND ANALYSIS

- Materials Analysis
- Thermal Analysis
- Supply Chain Analysis
- TEA/LCA Modeling



Presentations
Room: Potomac
From 8:30-12:30

Battery Materials Research (BMR)

Tien Duong

- **Why?**
  - Research on new materials for **beyond Li-ion** batteries. **Safe, abundant materials** with higher capacity and lower cost, such as sulfur, solid electrolytes and lithium.
- **Issues:**
  - Li metal: Reactivity and dendrite growth
  - Sulfur: Polysulfide shuttle
  - Solid Electrolytes: Low ionic conductivity and high interfacial resistance
- **Approaches:**
  - Develop advanced modeling and characterization techniques to investigate and mitigate the reactivity at the interphases/interfaces.
  - Engineer a host for lithium and/or an artificial SEI layer to protect lithium surface
  - Design novel structures to encapsulate polysulfides

Battery Materials	Specific Capacity (mAh/g)	Cost ($/kg)
Graphite	372	18.5
Li metal	**3,860**	**16.5**
NMC	~ 200	27
Sulfur	**1,673**	**~0**

- **Participants:** National Labs (7), Industry (2), Academia (23)
- **7 Topic Areas, 51 research projects**

Topic Area	Projects
Modeling	11
Diagnostics	10
Polymer and Solid-state Electrolytes	10
Metallic Lithium	7
Sulfur Electrodes	7
Air Electrode/Electrolyte	3
Sodium-ion Batteries	3
Total	**51**

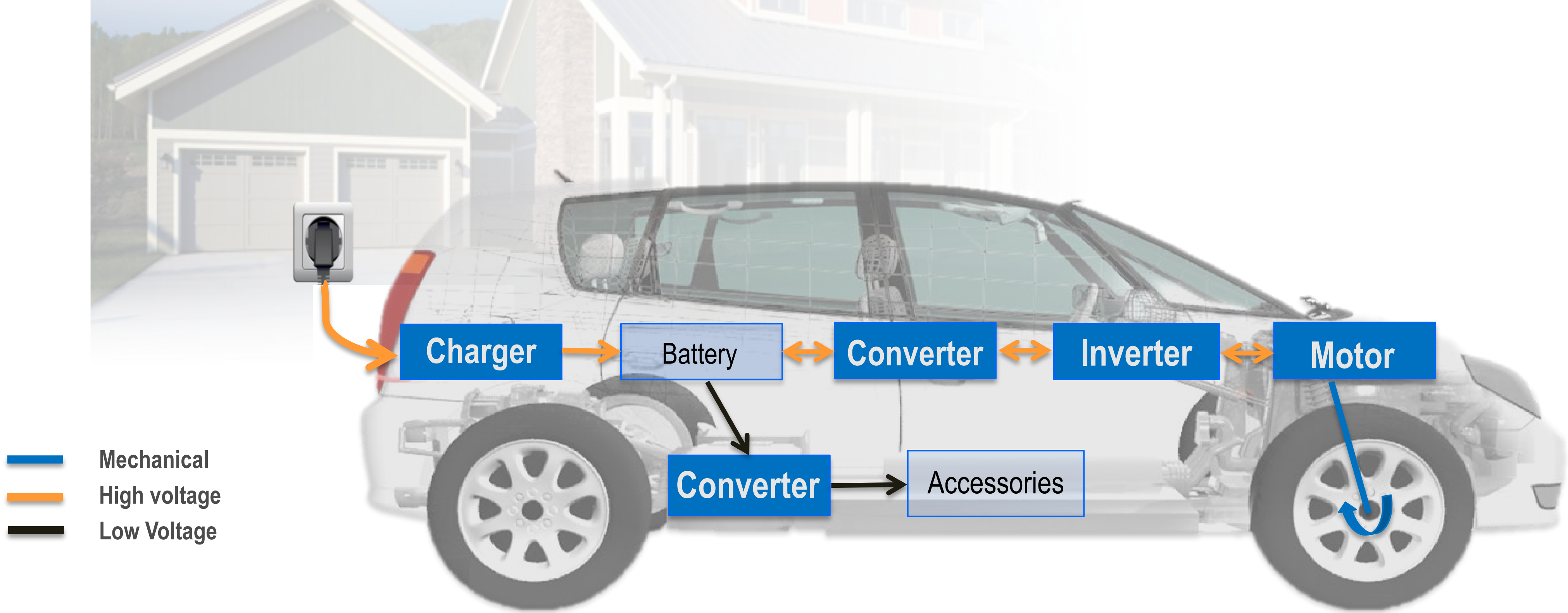
Electric Drive Technologies (EDT) R&D

Charger – modifies and controls electrical energy to charge the battery

Converter – increases battery voltage for traction drive system & decreases voltage for accessories

Inverter – converts direct current to alternating current for the electric motor

Electric motor – converts electrical energy to mechanical power



Integration reduces electric drive system cost and improves efficiency

EDT Consortium

Oak Ridge National Laboratory

Sandia National Laboratories

NREL National Renewable Energy Laboratory

The Ames Lab

University of Arkansas

Georgia Tech

Wisconsin University of Wisconsin–Madison

Purdue University

NC State University

The Ohio State University

Virginia Tech

SUNY Polytechnic Institute

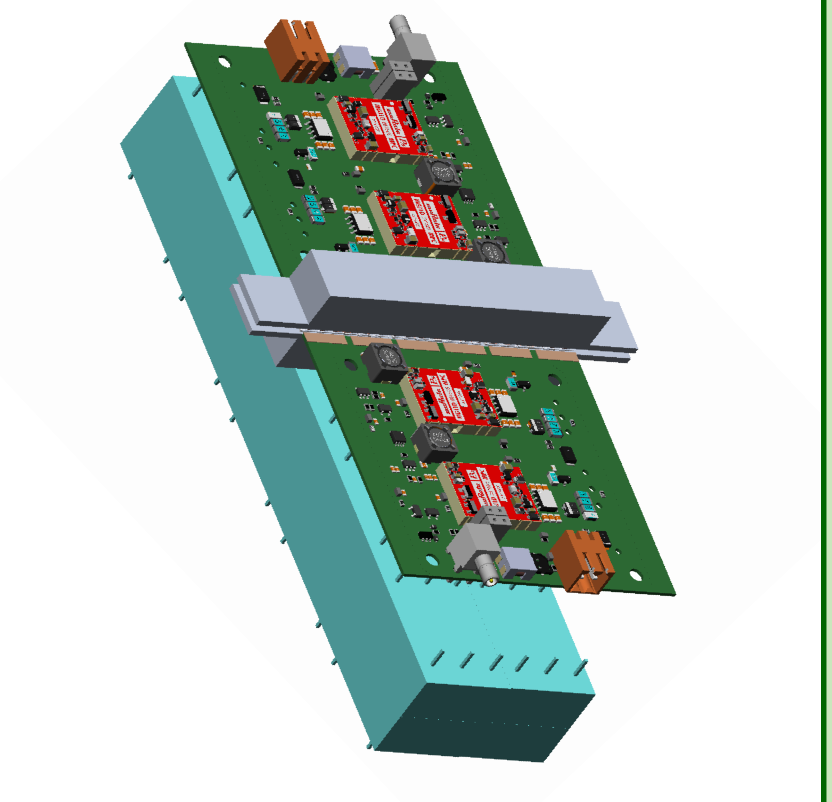
Illinois Institute of Technology

Berkeley University of California

EDT Consortium Keystone Projects

Keystone Project #1

Highly Integrated Power Electronics



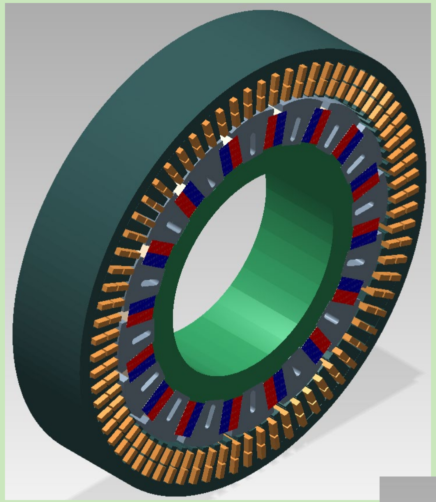
Three-Phase Linear Inverter

Quilted Chips, Gate Drive Chips & Cards, Capacitor Bank, Liquid Cooled Heat Sink

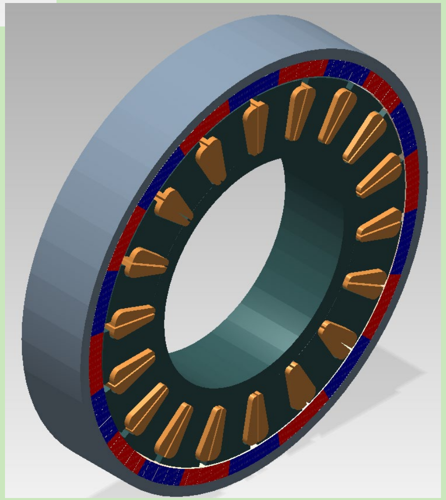
Total Volume ~ 0.7 Liters

Keystone Project #2

High Speed Electric Motors



Spoke Internal Permanent Magnet

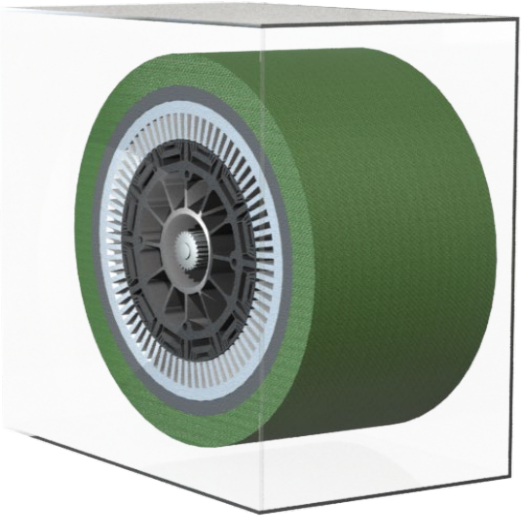


Outer rotor Surface Permanent Magnet

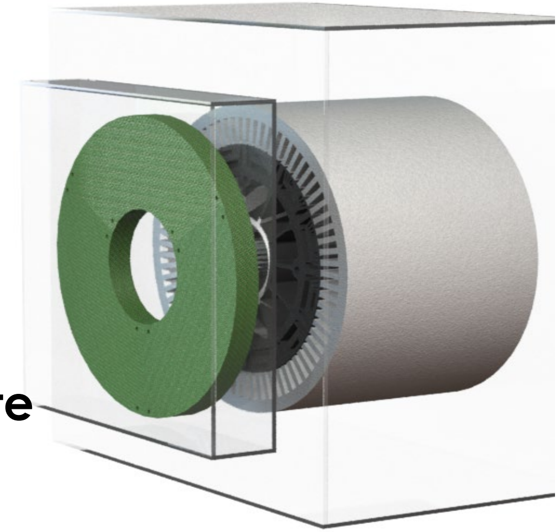
Keystone Project #3

Integrated Drive Systems

Radial Stator Mount

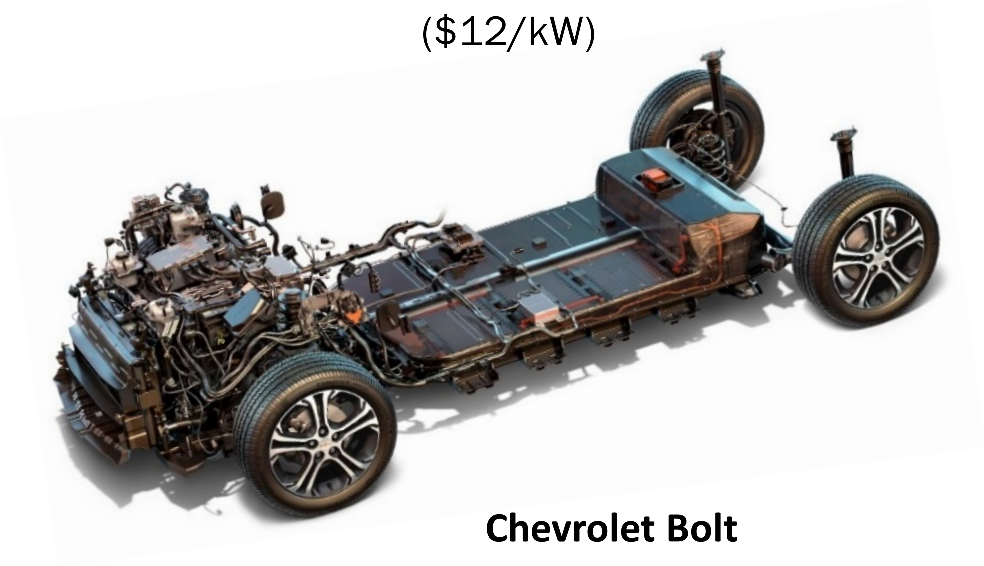


Axial Endplate Mount



EDT Consortium Targets

2015 Baseline
$1800
($12/kW)



Chevrolet Bolt

2025 Target
$900
($6/kW)

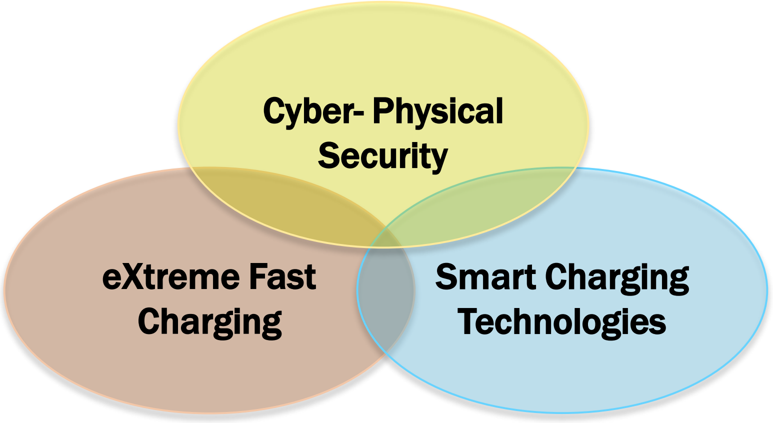
Future Mobility Design Concept

2025 Targets		
Cost	$ 900	50% reduction
Power Density	33 kW/L	843% increase
Reliability/lifetime	300,000 miles	100% increase

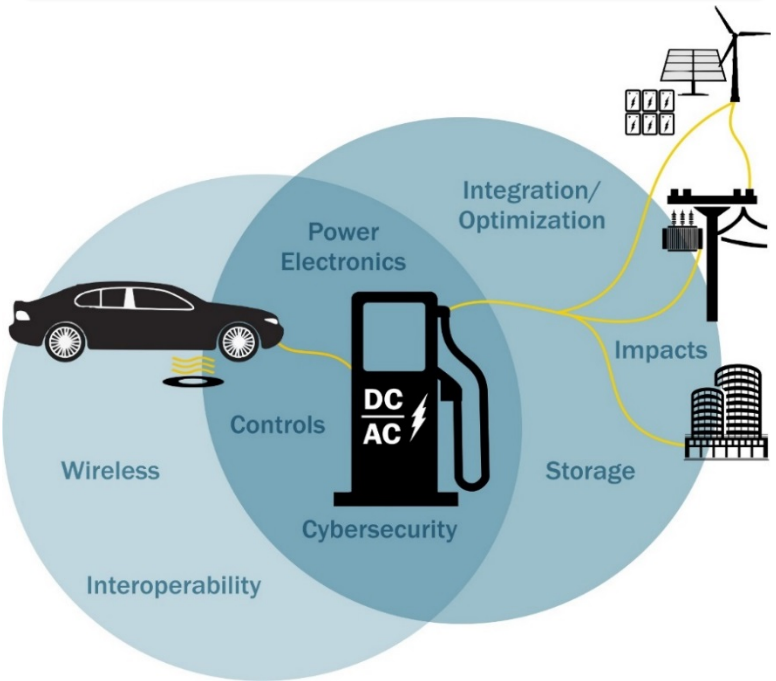
Grid and Infrastructure R&D for Electrified Transportation

Lee Slezak

- R&D efforts to develop EV charging infrastructure that is interoperable, interconnected, secure, & resilient
- EV charging landscape is evolving rapidly with MD & HD vehicle charging at rates up to 1.5 MW
- Barriers to Grid and Infrastructure R&D:
  - Meeting the diverse needs of EV users, charging networks, Distributed Energy Resources (DERs), and the grid;
  - Evolving cyber-physical threats; and
  - Efficient energy transfer for high power charging
- Approach: National lab and industry led early stage R&D guided by stakeholder interaction and engagement



Grid & Infrastructure R&D Focus



Panel 3 – Energy Efficient Mobility Systems, Analysis, and Technology Integration

David Anderson, Program Manager, Energy Efficient Mobility Systems

Erin Boyd, Technology Manager

Prasad Gupte, Technology Manager

Heather Croteau, Technology Manager

Mark Smith, Program Manager, Technology Integration

Dennis Smith, Technology Manager

Linda Bluestein, Technology Manager

Connie Bezanson, Education and Outreach Manager

Jacob Ward, Technology Manager

ENERGY EFFICIENT MOBILITY SYSTEMS

R&D AT THE **VEHICLE, TRAVELER, & TRANSPORTATION SYSTEM** LEVELS

CREATING **KNOWLEDGE, TOOLS, INSIGHTS, & TECHNOLOGY SOLUTIONS**

TO IMPROVE **EFFICIENCY, AFFORDABILITY, CONVENIENCE, OPPORTUNITY**

EEMS Team:	David Anderson	Erin Boyd
	Prasad Gupte	Heather Croteau

SMART Mobility Lab Consortium

Advanced R&D Projects

U.S. DEPARTMENT OF ENERGY

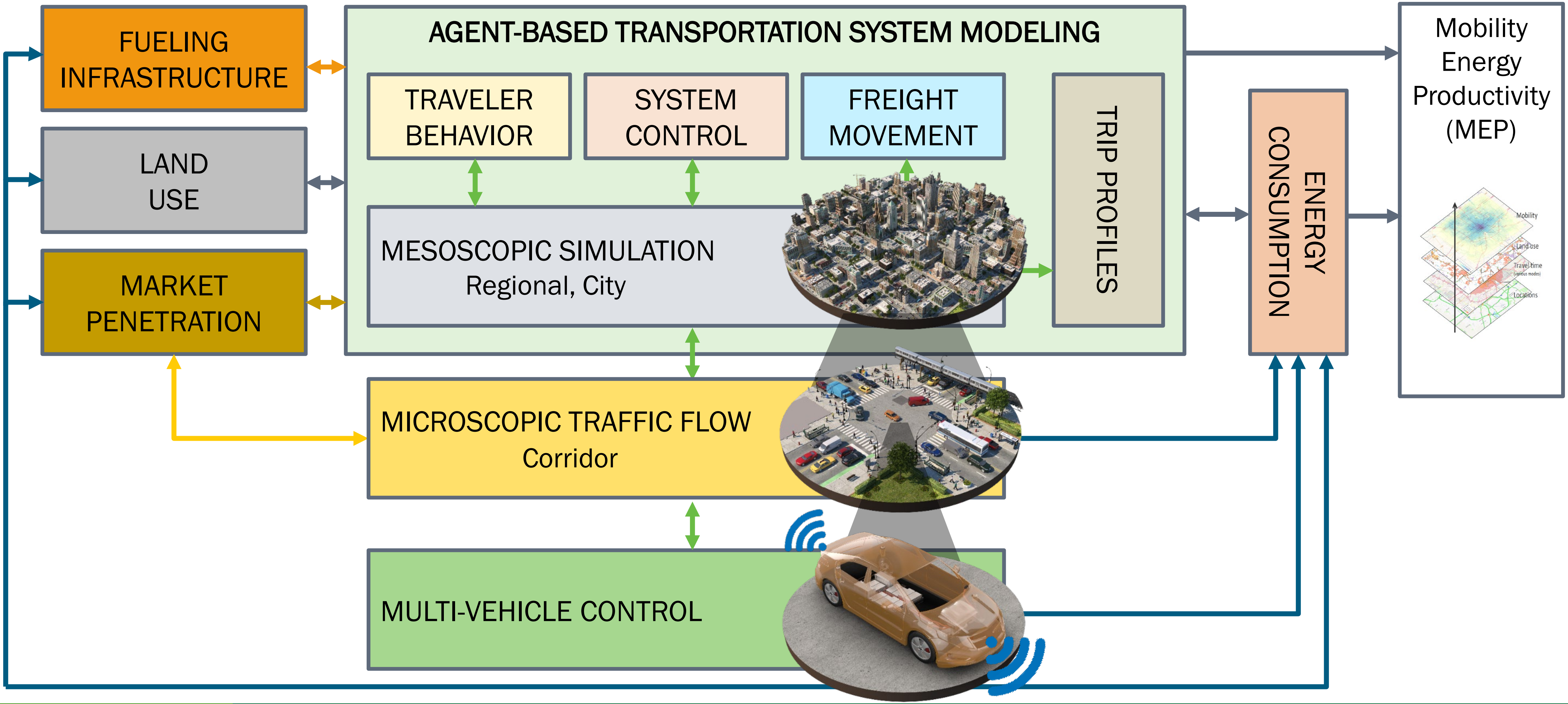
SMARTMOBILITY

Systems and Modeling for Accelerated Research in Transportation

Data Analytics

End-To-End SMART Modeling Workflow

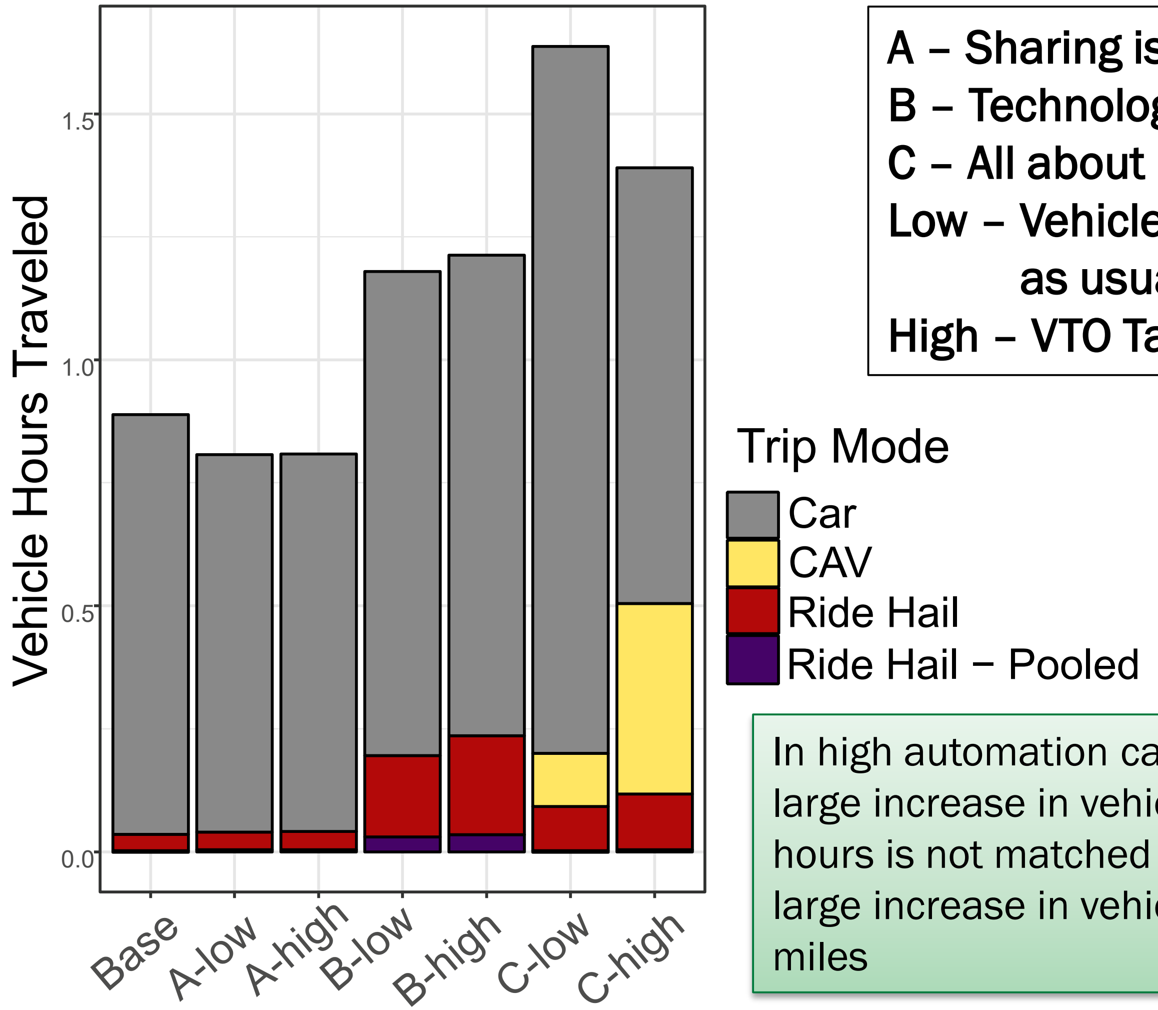
Erin Boyd



Agent Based Model Results

BEAM – Session EEMS 011

Per Capita Light Duty Vehicle Hours Traveled

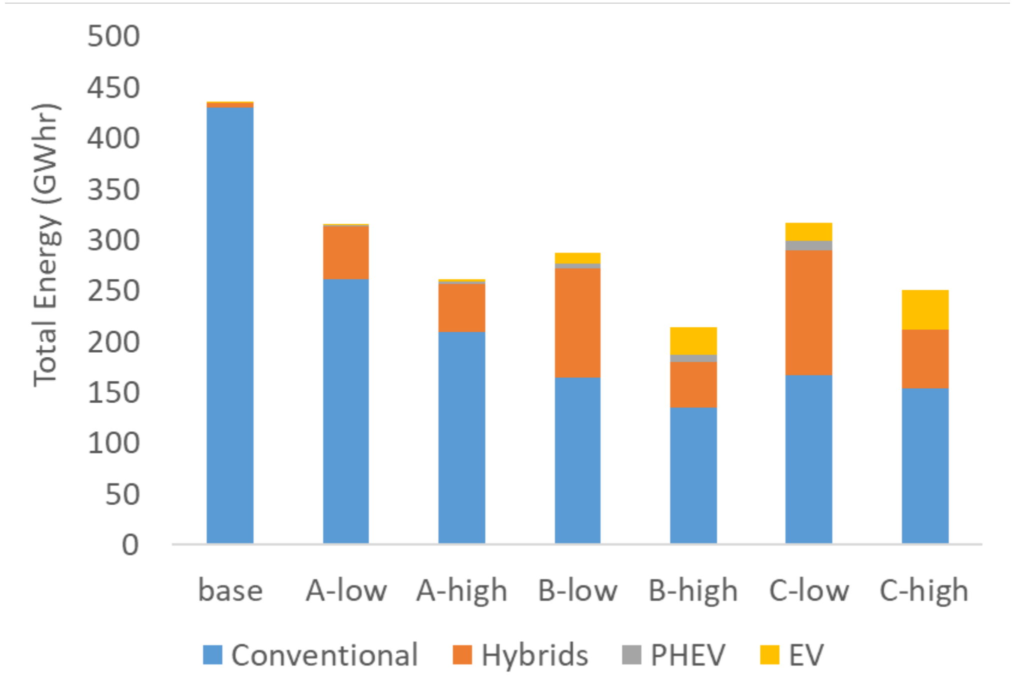


A – Sharing is caring
B – Technology takes over
C – All about me
Low – Vehicle business as usual
High – VTO Targets

In high automation cases, large increase in vehicle hours is not matched by large increase in vehicle miles

POLARIS – Session EEMS 017

Energy use by scenario



Private automated vehicles less efficient than shared fleets for regional mobility and energy

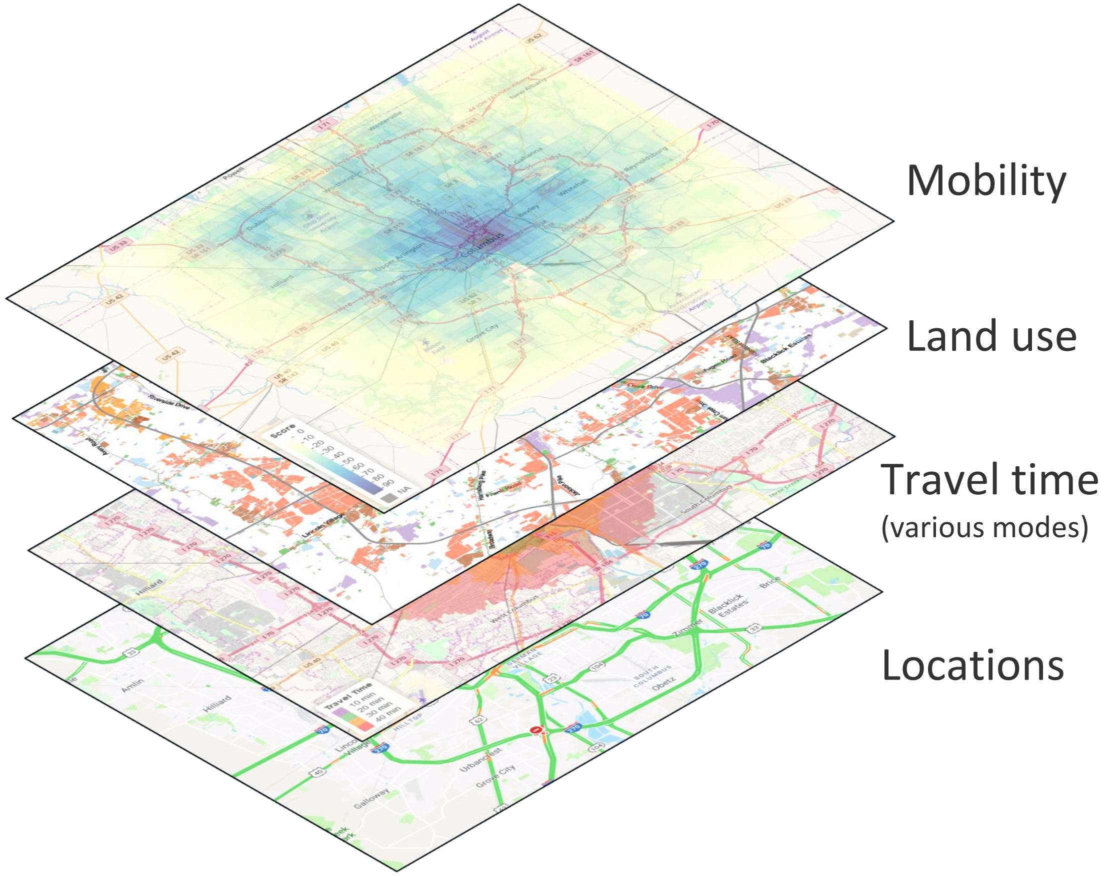
Motivation

- What is Mobility?
  - The quality of a network or system to connect people to goods, services, and employment that define a high quality of life.
- *Can we quantify energy and mobility tradeoffs, particularly for new mobility technologies and systems?*

Development of a methodology to more comprehensively assess mobility:

- Mobility Energy Productivity

MEP – Session EEMS057



How Do We Evaluate *Progress?*

- **Quantify the number of opportunities** that people can reach within a certain travel time threshold by different transportation modes
- The opportunities measure is **weighted by the energy efficiency metrics** of different transportation modes

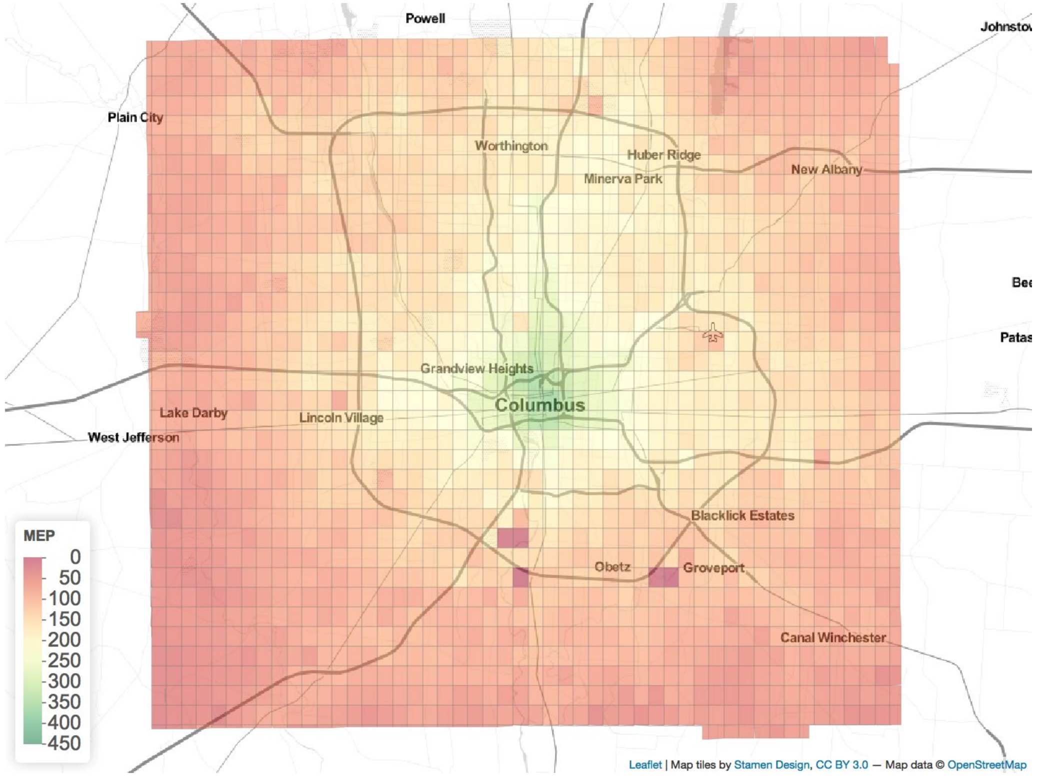
- Average the energy-weighted mobility values across all activities by **frequency of trip purpose**

- The opportunities measure could be further **weighted by the travel cost** of each mode
- MEP measures **opportunity access potential**, at a location for the existing modal spectrum

MEP = f (opportunity, time, energy efficiency, cost)

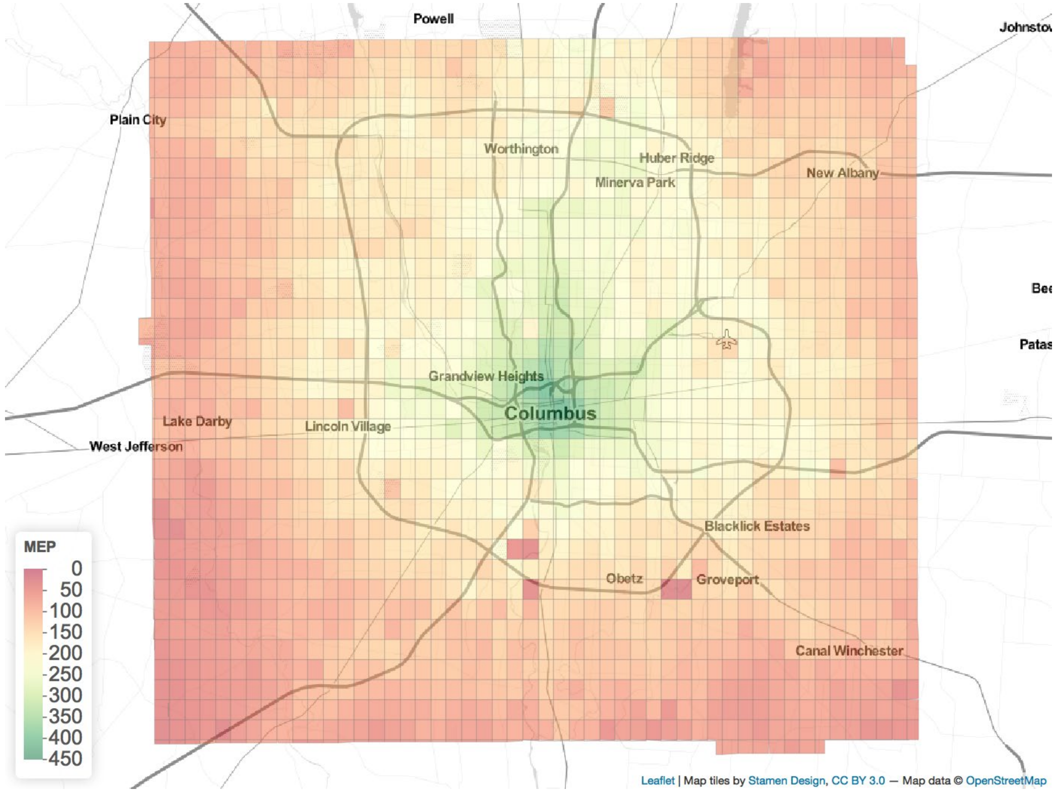
Impact of TNC on MEP (illustrative and preliminary example)

MEP: Columbus (no TNC)



Population Density Weighted Metric: 162

MEP: Columbus (WITH TNC)



Population Density Weighted Metric: 198

Caveat: The TNC MEP computation does not account for any secondary effects of TNCs such as increased travel (due to deadheading) or congestion effects.

...but what *IS* Energy Efficient Mobility Systems

Heather Croteau

...and why Vehicle Technologies Office


Source: Volvo

Source: SMRT

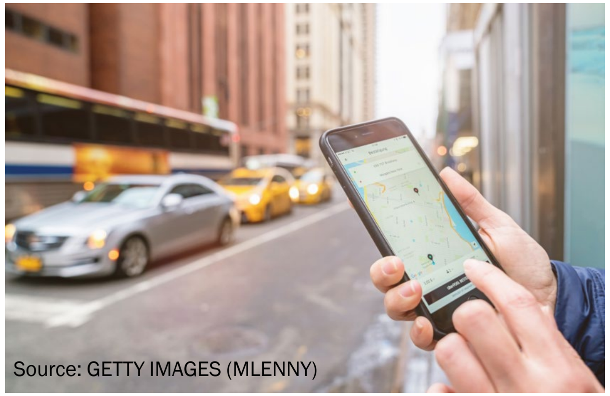
Source: Warner Brothers

Source: ITALDESIGN

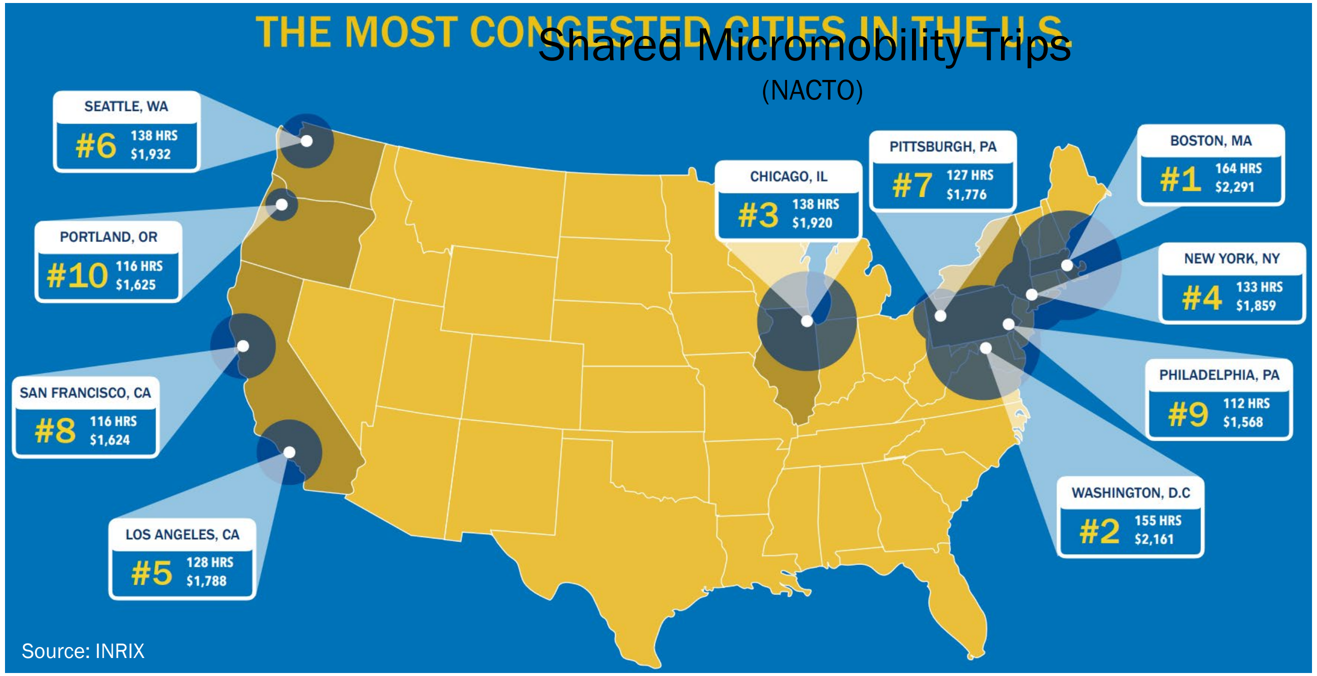
...but what *IS* Energy Efficient Mobility Systems


Source: Lime


Source: InBin


Source: GETTY IMAGES (MLENNY)


Source: AP



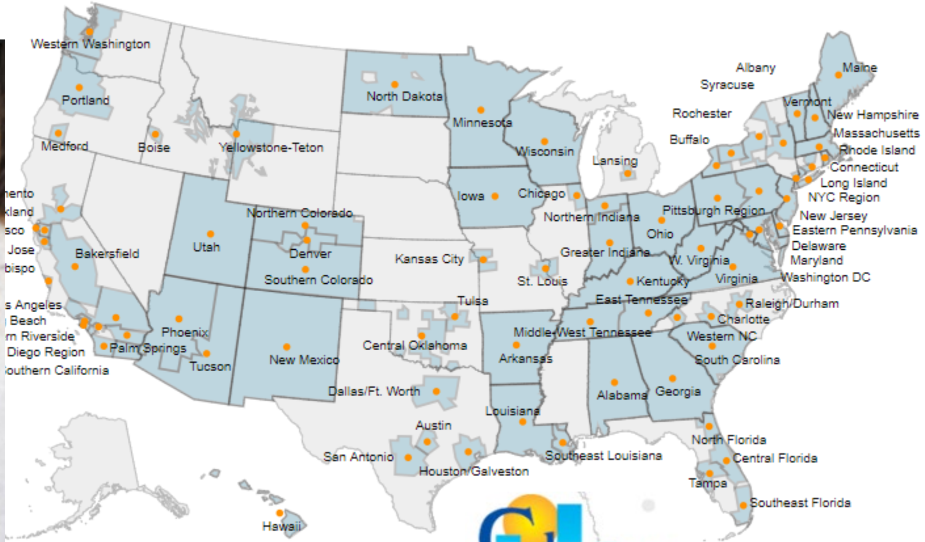
Shared Micromobility Trips
(NACTO)

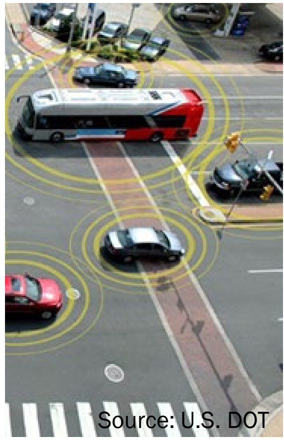
Source: INRIX

Okay…but why Vehicle Technologies Office

Source: NACTO

Source: ZF




Source: U.S. DOT

Energy Efficient Mobility Systems

Batteries and Electrification	Materials	Advanced Combustion & Fuels	Technology Integration	Analysis

What Is Technology Integration?

Mark Smith

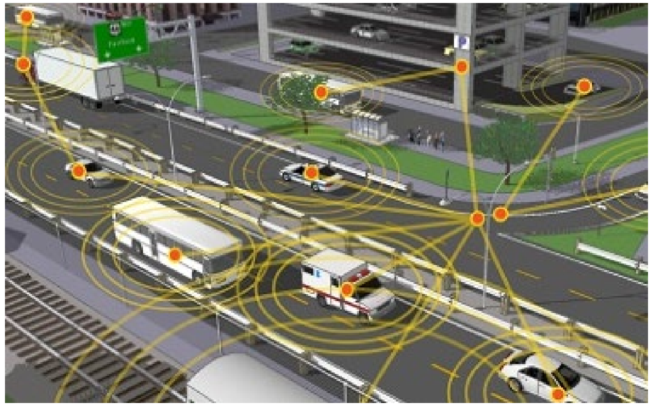
- **Data and Systems Research**
- **Advanced Vehicle Technology Competitions**
  (EcoCAR Mobility Challenge)
- **State and Alternative Fuel Provider Fleet Program**

Technology Integration Core Activities

Technology Integration Focus Areas

Light, medium and heavy-duty vehicles


Alternative Fuel Infrastructure

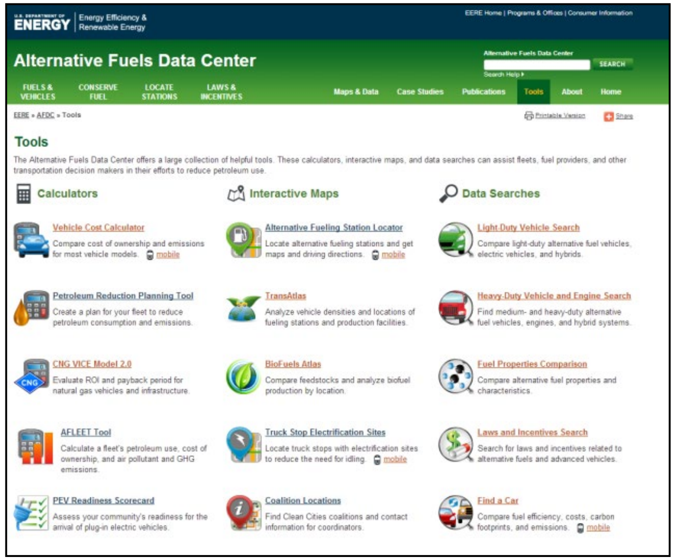


Energy Efficient Mobility Systems and Technologies

Technology Integration

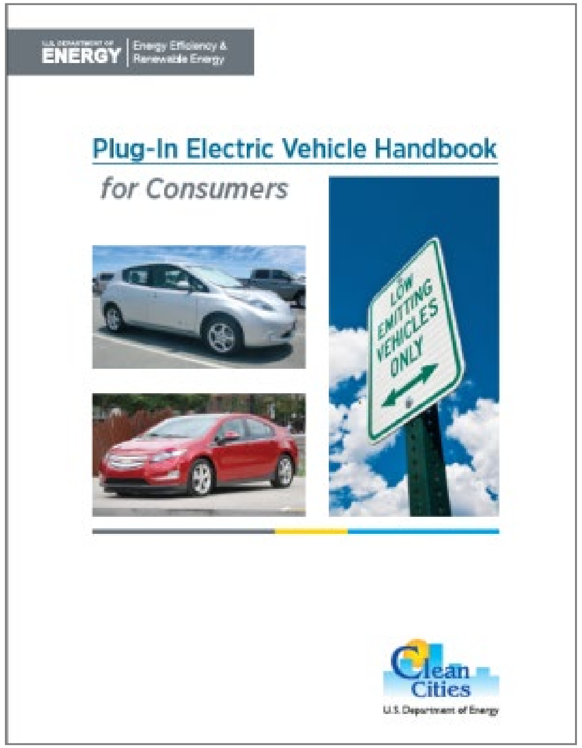
Technology Integration Tools, Data, and Resources

- Non-biased source of VTO data and information
- Fuel Economy Guide (FE.gov), Alt-Fuel Data Center (AFDC)
- On-line station locator, tools, cost calculators, other web and smart-phone apps & resources
- Fact Sheets, publications, handbooks, case studies
- Technical Response Service and Hotline



Online Tools

Technical Response Service



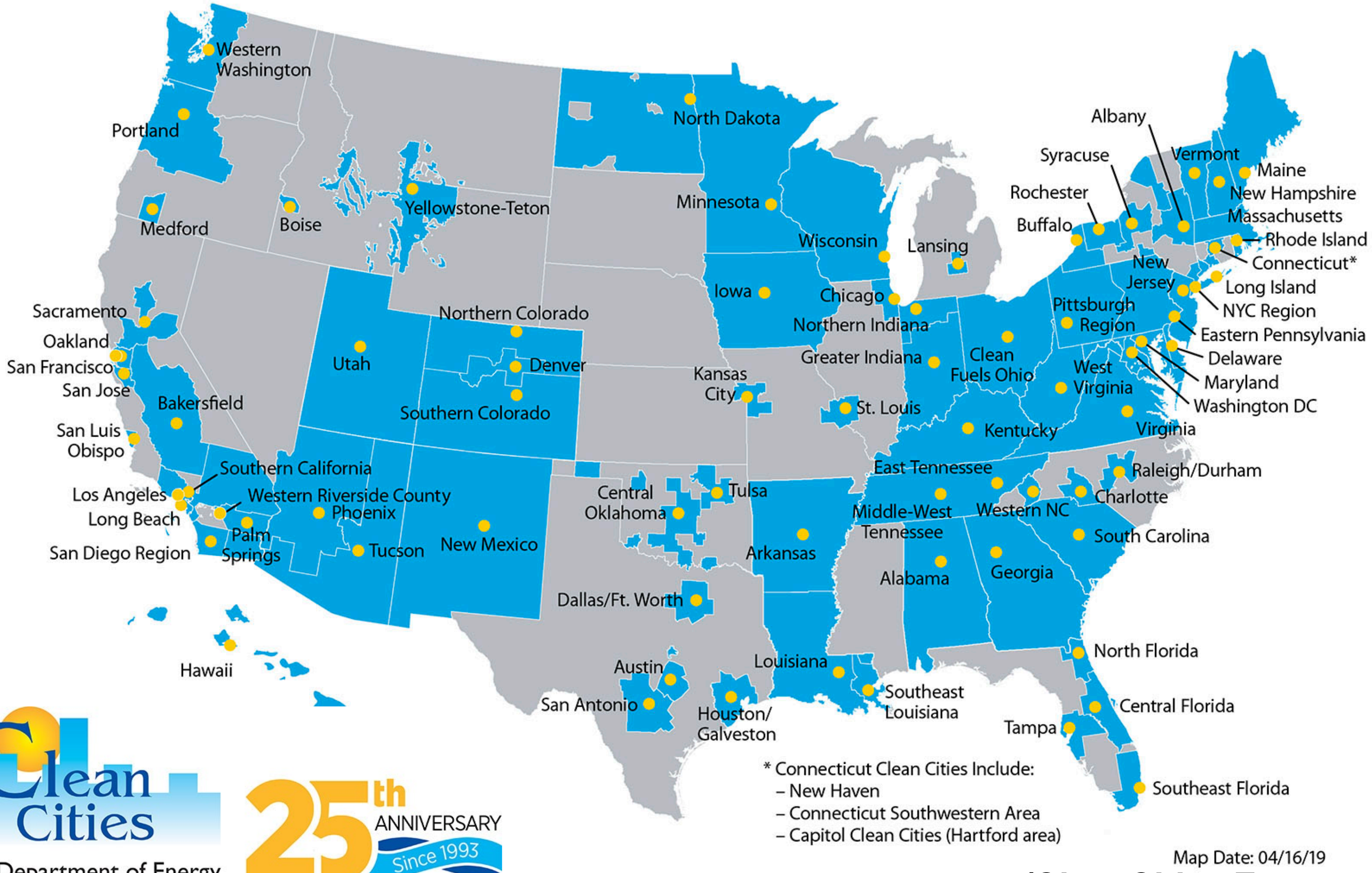
Publications

Technical and Problem Solving Assistance

NGVTF
Natural Gas Vehicle Technology Forum

- Capture lessons learned and best practices
- Technical Forums and User Groups
- Address unforeseen permitting & safety issues
- Identify chronic vehicle or infrastructure field problems
- Incident investigations
- Inform future R&D with real world experiences

Nearly 100 Clean Cities coalitions with thousands of stakeholders, representing ~80% of U.S. population



Clean Cities
U. S. Department of Energy

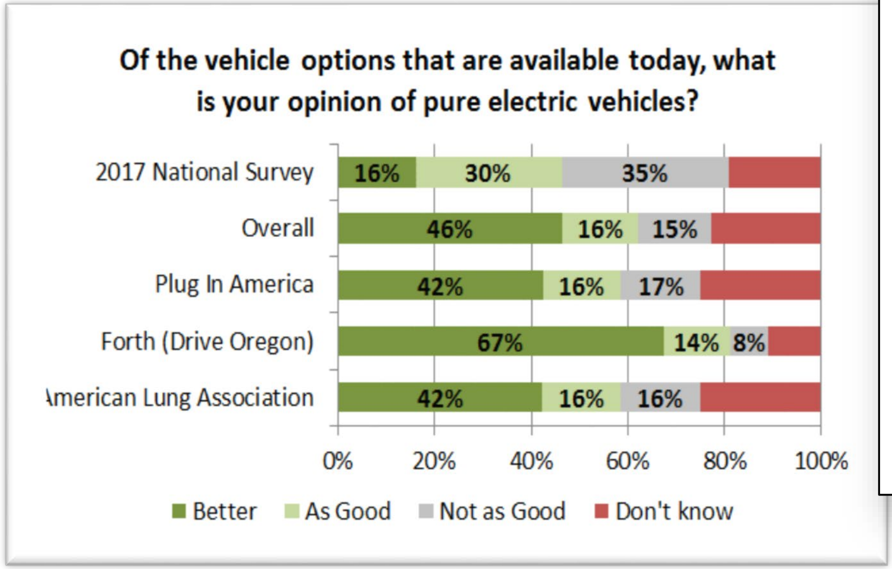
25th ANNIVERSARY Since 1993

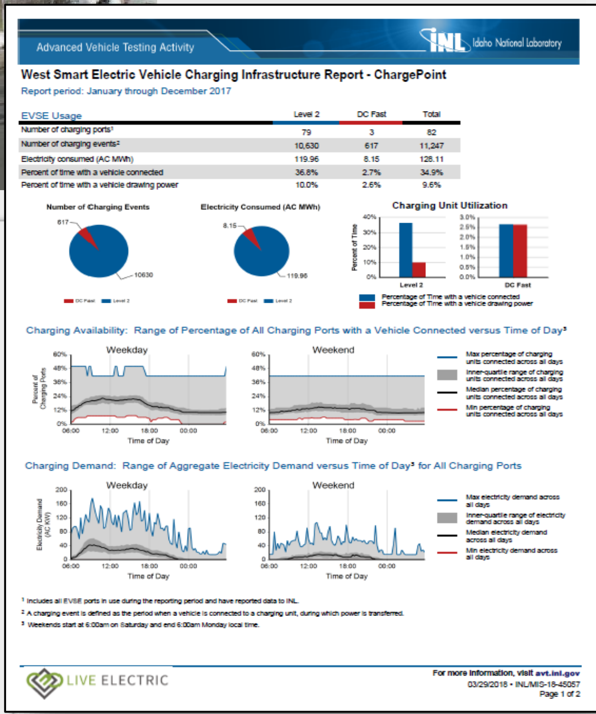
(CleanCities.Energy.gov)

Technology Integration Support and Portfolio

Linda Bluestein

- Demonstrate innovative vehicle technologies and practices:
  - benefit end users,
  - increase resiliency
  - reduce costs
  - feedback to researchers
- <u>Barriers?</u>
  - Cost
  - lack of user knowledge, experience and data





Advanced Vehicle Testing Activity

Idaho National Laboratory

West Smart Electric Vehicle Charging Infrastructure Report - ChargePoint

Report period: January through December 2017

EVSE Usage	Level 2	DC Fast	Total
Number of charging ports[1]	79	3	82
Number of charging events[2]	10,630	617	11,247
Electricity consumed (AC MWh)	119.96	8.15	128.11
Percent of time with a vehicle connected	36.8%	2.7%	34.9%
Percent of time with a vehicle drawing power	10.0%	2.6%	9.6%

[1] Includes all EVSE ports in use during the reporting period and have reported data to INL.

[2] A charging event is defined as the period when a vehicle is connected to a charging unit, during which power is transferred.

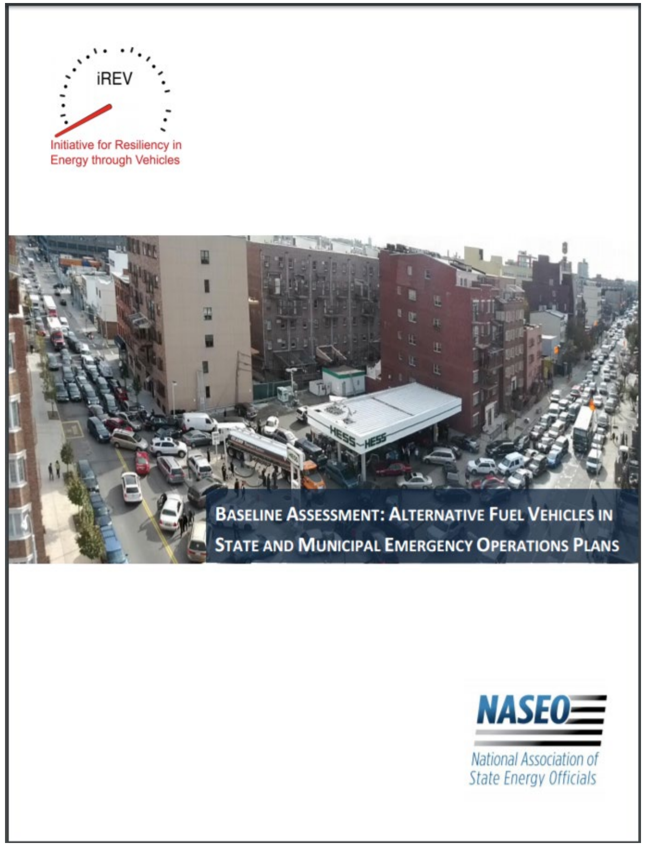
[3] Weekends start at 6:00am on Saturday and end 6:00am Monday local time.

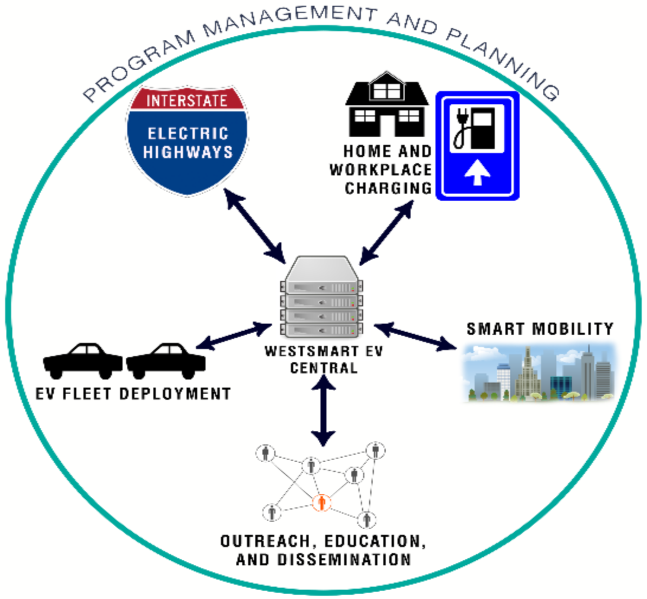
LIVE ELECTRIC

For more information, visit avt.inl.gov
03/29/2018 • INL/MIS-18-45057
Page 1 of 2

Technology Integration Support and Portfolio

Training – Experience/Education -- Safety -- Resiliency -- Infrastructure -- Living Labs





USING REAL-WORLD DATA TO UNDERSTAND ENERGY IMPACTS

3 Living Laboratory Projects $4.9M in FY2017

2019 Oral Project Reviews:

Living Lab Projects and other TI projects

Tuesday June 11 8 AM - 11:30AM

Location: Theater

ELECTRIC SHARED MOBILITY

Seattle, Portland, NYC, Denver
Uber, Maven, Reachnow

ELECTRIC LAST MILE

Austin
Pecan Street, CapMetro

ENERGY EFFICIENT FREIGHT LOGISTICS

NYC-Albany Corridor
Rensselaer Polytechnic Institute, freight carriers & receivers, urban supply chain

Advanced Vehicle Technology Competitions

Developing the scientists and engineers to address our energy needs.

- ***93 North American universities*** have participated since 1989.
- ***69 patent applications*** submitted by AVTC graduates
- More than ***20,000 students*** have participated
- EcoCAR 3 students:
  - 89% engineering (90% undergrad)
  - 17% women
  - earn more - $8,600 on average*

ECO CAR
MOBILITY CHALLENGE

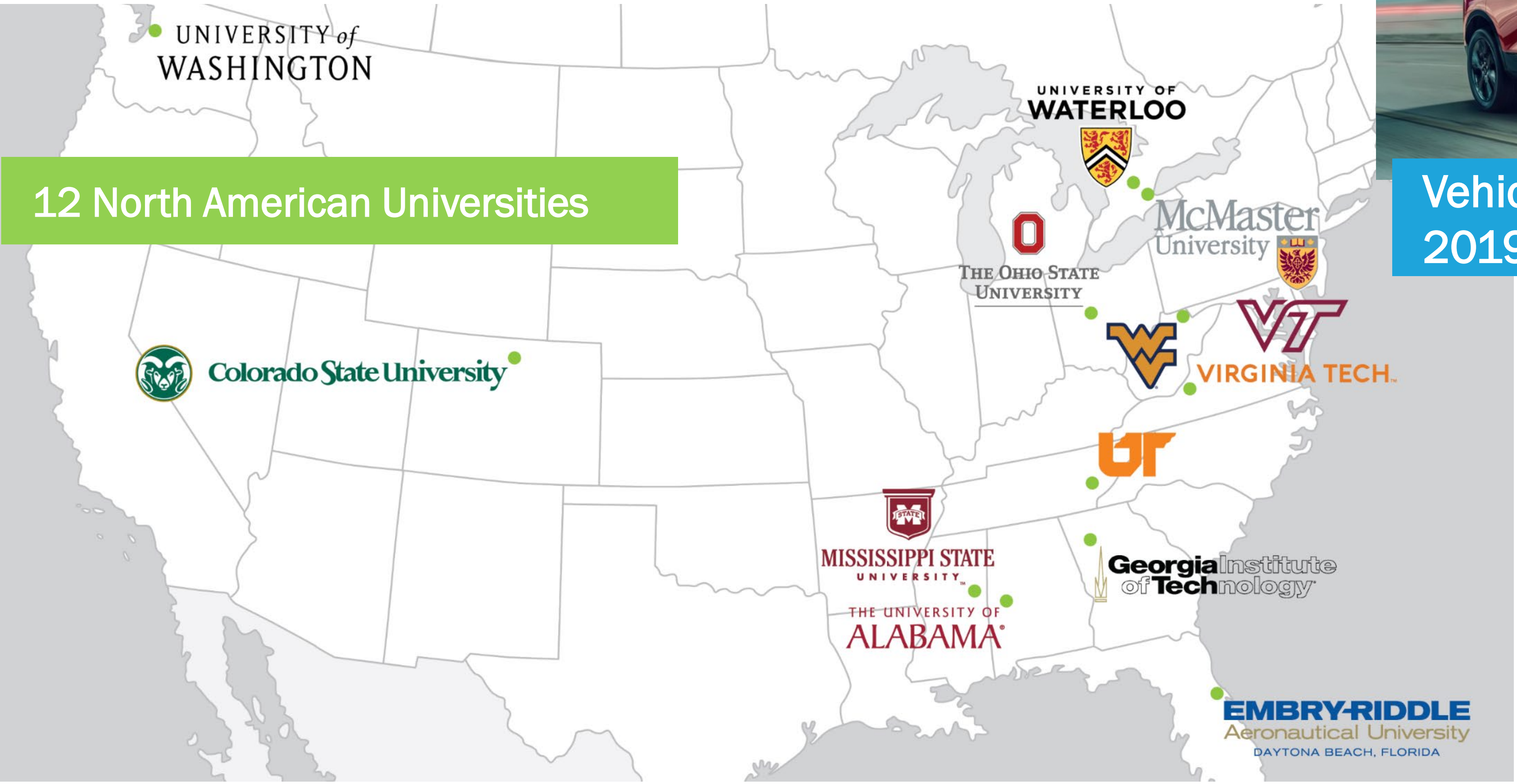
* Technology Integration 2018 Annual Progress Report, Vehicle Technologies Office.

ECO CAR MOBILITY CHALLENGE

U.S. DEPARTMENT OF ENERGY

GENERAL MOTORS

MathWorks



12 North American Universities

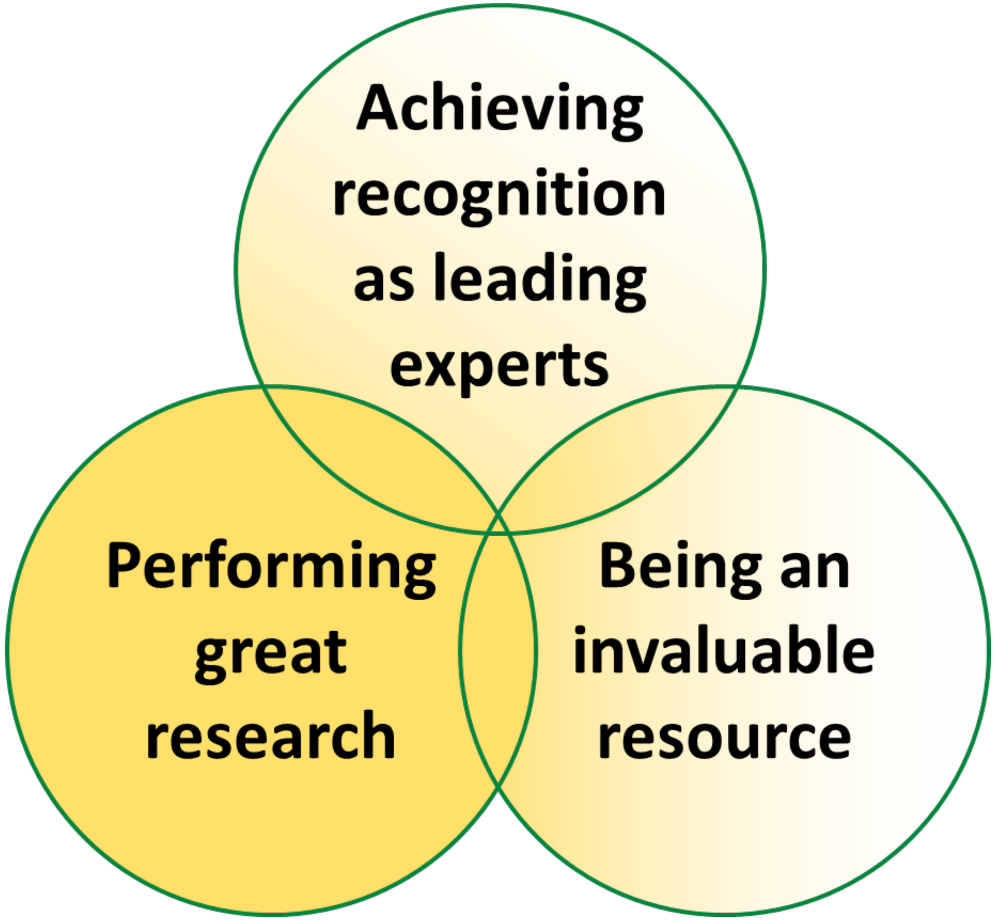
Vehicle Platform:
2019 Chevrolet Blazer

40% of competition activities focused on CAV technologies

VTO Analysis Strategic Visioning

Jacob Ward

- Data-driven transportation technology analysis:
  - answers critical questions
  - creates insights about energy use and other relevant metrics
  - supports office-wide goals and targets
  - identifies gaps, opportunities, and challenges
- Efforts overcome silos, balance big-picture with detail/nuance, and pursue objectivity and trustworthiness
- Analysis capabilities and expertise anticipate and respond to immediate office needs and identify longer-term strategic opportunities



VTO Analysis Strategic Goals

VTO Analysis

(1) Collect, synthesize, and make public **DATA** and insights

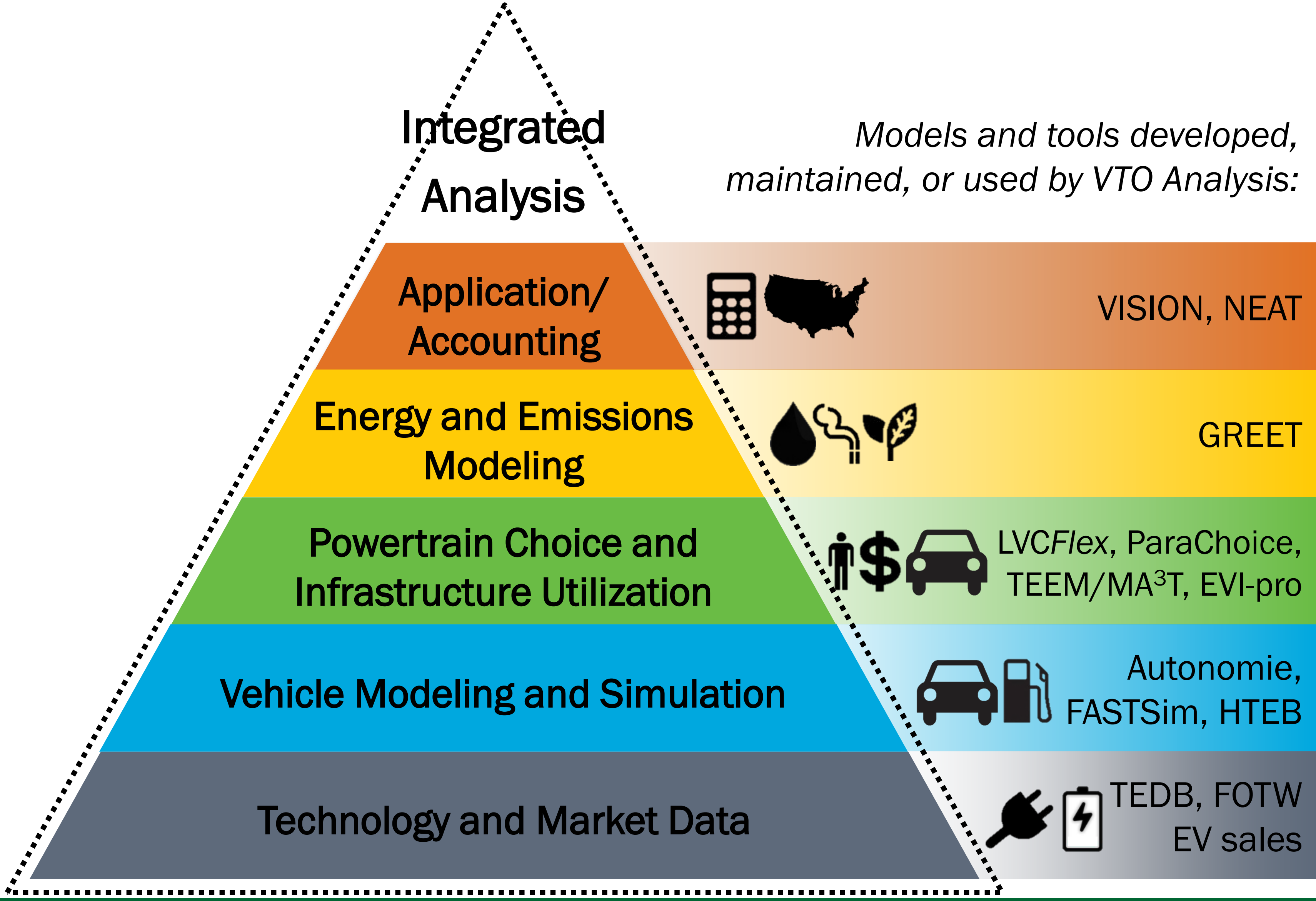
↓

(2) Use data to build, maintain, and expand robust **MODELING** capabilities

↓

(3) Apply models for impactful **ANALYSIS** to answer priority research questions

VAN AMR presentations Thursday morning in the Theater; posters Wednesday evening



Conclusion

Reviewer Orientation 5:45pm to 6:15pm (Washington Room)